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EDITORIAL.

STANDING on the threshold of a new century, whose secrets in the advance of science have yet to be unfolded, the humblest worker in the illimitable field may well look back on the achievements of the nineteenth century with admiration—perhaps with awe—as he turns his face hopefully to the work of the twentieth century. A hope that, as in past so in future decades, the arm of science may be lengthened by the force of master intellects, will urge forward, and not deter, the humble toiler in his labours.

One of the pleasing duties attaching to our position in the ranks of strenuous enquirers after truth is that of expressing our thanks to the many friends—readers and writers alike—who have aided us in our work during the past year.

In making our customary announcement of some of our projects for the new year, it is with pleasure that we note an increasing popular interest in Astronomy. In this connection Mr. Maunder proposes to continue his interesting series of articles on "Astronomy without a Telescope" under the title of "Constellation Studies." These articles will be illustrated by a set of star charts and maps, which are being specially prepared for KNOWLEDGE. Arrangements have also been completed with some writers new to our pages, who will contribute to the Astronomical work of the year. Among these, Prof. D. P. Todd, Director of Amherst College Observatory, Massachusetts, will write on "The Construction and Working of a Special Instrument for Eclipse Photography"; the Rev. A. L. Cortie, S.J., F.R.A.S., on Sunspots; Prof. A. W. Bickerton, of New Zealand University, on "The Evolution of the Solar System" and on "The Evolution of the Galaxy"; and Mr. Robert Brown, Jun., F.S.A., on "The Constellation Figures in Greek Coin Types."

We hope to publish early in the year the first of a short series of illustrated articles on "Waves," by Mr. Vaughan Cornish, descriptive of his investigations during the past six years on the Chesil Beach, the Sand Dunes in Egypt, the Goodwin Sands, and other places. These articles will be in continuation of the writer's former series of papers on "Waves," which appeared in our columns some years since.

Arrangements have also been completed for a series of six articles on the Insects of the Sea, by Mr. G. H. Carpenter, B.SC., and a series of six popular papers on Flowering Plants, by Mr. R. Lloyd Praeger, who will take for his subjects the struggle for existence, plant dispersal, and the flora of Ireland. Mr. R. Lydekker, F.R.S., will contribute to the January number an illustrated article on Monkey Hand-prints, to be followed by a paper from the same pen on the Identification of Individuals by means of Finger Prints. The Rev. T. R. R. Stebbing, F.R.S., has promised to write on some singular groups of *Arthropoda*; the Rev. J. M. Bacon, M.A., F.R.A.S., on "Storms and Storm Clouds as Observed from a Balloon," and "Bells and their Value as Warning Signals"; and Mr. Harry F. Witherby will recount some of his experiences in a recent ornithological expedition to the White Nile.

Contributions in Astronomy are also promised by Mr. A. C. D. Crommelin, Mr. John Evershed, Mr. A. Fowler, Mr. J. E. Gore, and Prof. E. C. Pickering; and on Colour Photography, by Mr. H. Snowden Ward; on Rockall, by the Rev. W. S. Green; on Standard Silver, by Mr. Ernest Smith; and in Geology, by Prof. G. A. J. Cole. Mr. W. F. Denning continues his interesting column on "Comets and Meteors," and Mr. Fowler will foretell, as heretofore, "The Face of the Sky" month by month.

Following the announcement in our Chess Column in the present number, Mr. C. D. Locock will commence a Solution Tourney in the January issue, and we hope to publish original articles on the game from the pens of some leading players during the year.

We have also arranged with Mr. M. I. Cross, the joint author with Mr. Martin J. Cole of the well-known "Handbook of Modern Microscopy," to conduct the column on Practical Microscopy during the year.

XUM

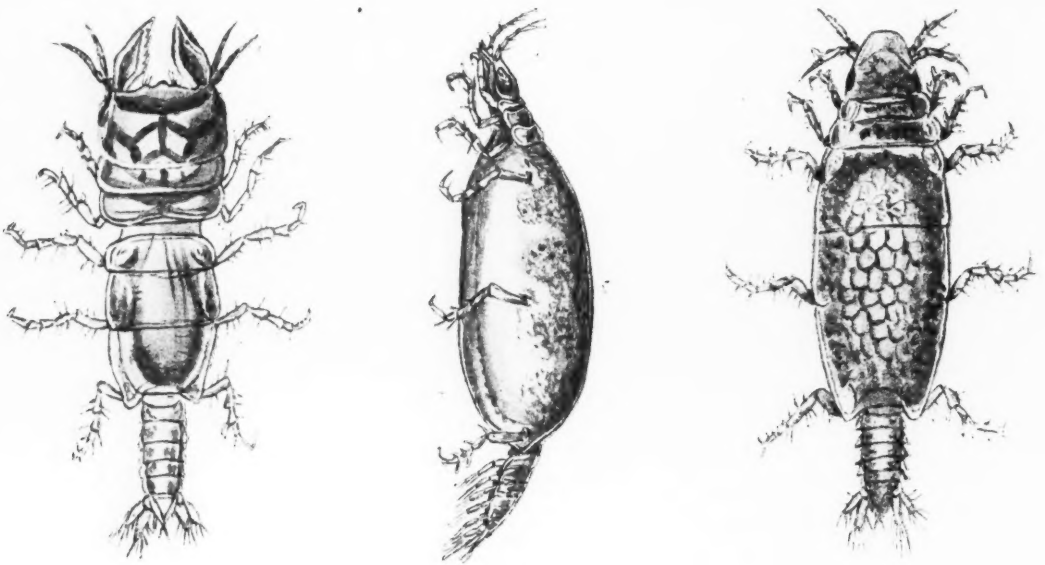
THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

CRUSTACEAN NURSERIES.

To be rocked in the cradle of the deep is the lot of many juvenile crustaceans, and, however forlorn it may sound, it exactly suits their constitution. So long as the brood remain attached to the mother's body, on trunk or pleon, on back or front, in pouches or free, in irregular masses or shapely packets or long pendant strings, varying arrangements of the maternal organism or mode of life provide for their health and welfare. But upon detachment, whether before or after hatching, the young pass out of the mother's care. Sometimes the separation takes place under such circumstances that the mother is sure to be dead before the birthday of her offspring arrives. Obviously in the intermediate period they cannot maintain any active struggle for existence. Many no doubt succumb, without ever a chance of climbing up the climbing wave, but quite enough survive, sheltered in safe inglorious mud, to become portions and parcels of the fateful future. Sometimes the young have habits quite different from those of their parents and of necessity live apart. Even where the display of maternal care and affection is not physically impossible, it can be little needed in this extremely prolific class of animals, and the records of it, which are partly discredited by their rarity, cannot be accepted without corroboration. There is the little globular entomostracan *Chydorus sphaericus* (Müller), of which Dr. Baird says, "According to Pritchard, the young play near their parent, and at the approach of danger swim for protection within the shell of the mother, which she, conscious of their feebleness, immediately closes." Since the mother herself is only a sixtieth of an inch in diameter, how powerful a microscope must Pritchard have used that could not only see into the maternal consciousness, but could also discern that the infants were "playing," that they had a sense of approaching peril, and that they knew where to flee for refuge! It is odd that the reciprocal affection thus pleasingly described should find no authentic counterpart in the highest ranks of the crustacea, in which they might have been perceived with some less exceptional instrument. The West Indian land-crabs must be far above any entomostraca in intellectual development, and they lay their eggs in the sea, thus leaving their young ones in a very literal sense to fish for themselves.

We speak of children as little men and women, and of men and women as children of a larger growth. Between cats and kittens there is a very close resemblance. People have been known to eat lamb mistaking it for mutton. Therefore, when an amphipod comes out of the egg a meek and miniature copy of its mother, that seems to be an ordinary and regular sort of performance. When a young woodlouse is born, a casual observer might think it a little off colour, but would probably deem it much like its parents in isopodan shape and structure, overlooking the absence of its last pair of legs or reckoning the want of two legs out of fourteen a trivial arithmetical detail. Nevertheless between the young and adult of a crustacean species there is sometimes so great a difference that science has long stumbled and stammered before recognising the relationship. To rear a species from the egg to maturity, under observation in an aquarium, may seem a facile method for dealing with any such questions of affiliation. The misfortune is that the foundlings to be operated on are in their early youth often of a very delicate constitution. Each moulting which leads them out of one shape into another is a crisis in their existence. Those who bring them up by hand must find out what temperature of the water they require, what amount of movement



A. B. C.

Gnathia maxillaris (Montagu). From Sars. A, Male; B, Larva; C, Female.

in it, what degree of salinity, how much light or shade they need, and what sort of food is suitable to them at each successive stage. They must be isolated, to prevent confusion with other species, and to protect them from possible enemies. If all the varying conditions of their existence were known beforehand, it might still be impossible to reproduce those conditions, but frequently they cannot be known until the problem demanding solution has been already solved.

Though the isopods are in general at birth nearly like their parents, there is a remarkable exception supplied by the family of the Gnathiidæ. This was for a long time split up into two families, until an ingenious French observer, M. Eugène Hesse, at last convinced the world, including even his opponents, that the mother and children which had been called *Praniza* were verily wife and offspring of a husband and father called *Gnathia*. Sometimes the young of this genus remain parasitic on fishes, gorging themselves, until the time comes for the greater self-restraint attending the remarkable structural changes which discriminate them as males and females. The Cymothoidæ also differ, though less strikingly, in the virgin and mature state.

In other orders many genera have been founded on forms now clearly understood to be immature. Some crustaceans pass through so many distinct stages that a single individual may belong in turn to several of these infantile genera before it becomes a veteran. A crab, for example, will often be a Zoea and then a Megalópa before assuming the features of a *Cancer* or a *Carcinus*, or whatever its full grown title may chance to be. In the luminous *Euphausia* seven larval stages demand their several names from Nauplius to Cyrtopia. The slender shrimps of the genus *Sergestes* have had many an alias, as *Acanthosóma*, *Elaphocáris*, *Sciacáris*, *Mastigopus*, which remain as a testimony to the trouble they have given zoologists by their fickleness of form before reaching adult life. In this particular genus Dr. H. J. Hansen has by careful examination of a very large collection arrived at a useful result. He finds that in the larvæ the eye-stalks are almost always long, the eyes rather or very large, pallid or but partially black, and more or less fungiform in shape, whereas in the adults the eye-stalks are rather short, the eyes smaller and more globular, and totally black. The young have dorsal spines, which disappear, sometimes indeed from the older larvæ, but always from the adults. Other characters are available for connecting the young of different stages and different species with their proper brothers and sisters and parents.

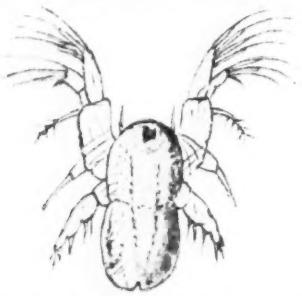
The great commercial value of the lobster and the obliging affability with which it so constantly visits the Scandinavian and Anglo-Saxon varieties of mankind have made its life-history a subject of successful study. Quite recently (1898) Mr. J. T. Cunningham has presented a very instructive report to the County Council of Cornwall on the methods and difficulties of lobster-rearing. Dr. Herrick in his valuable book on the American lobster (1895) explains that in the first larval stage, when the animal just escaped from the egg-capsule is only about a third of an inch long, "the body is segmented as in the adult form, the most striking characteristics being the enormous compound eyes, the conspicuous rostral spine, the spatulate telson, and the biramous swimming appendages, which, from their resemblance to the permanent swimming organs of the Schizopods, have given to this and the two succeeding forms the name of 'schizopod larvæ.'" There is food for thought, then, in a baby lobster. For whereas it is in its earliest life a schizopod, *Euphausia*, which is still a schizopod when adult, passes as above mentioned through seven simpler stages before reaching maturity. The enormous compound eyes are precisely the feature in the juvenile stage of crabs on which the supposed genus Megalopa was founded and named. The spatulate telson occurs also in the larval shrimps. The conspicuous rostral spine is not confined to young lobsters, but is a character which numbers of young malacostracans delight to display. This is very strikingly seen in the zoea of our common *Porcellana longi-*

Zoea longispina, Dana. Porcellanid larva. From Dana.

cornis (Linn.), and equally so in Dana's *Zoea longispina* from the Sooloo Sea. Dana thought that his species might be the young of an *Erichthus*, it not being known at that period that *Erichthus* is itself one of the genera founded on the young of the Squillidæ. It seems probable that the spikes with which larval crustaceans are so abundantly furnished form a defensive armour against foes of approximately their own size. The glassy transparence which many of them share with other animals that frequent the surface of the sea is also likely to be in some measure protective. Whether their large eyes are, as the wolf said to little Red Ridinghood, "the better to see you with, my dear," seems a little uncertain. Either for escaping enemies or for capturing food the small size of these larval forms and their limited powers of locomotion must put most of them much at the mercy of chance, making it rather disagreeable than otherwise for them to have a good look at the unattainable or the inevitable. Perhaps their eyes, by the impression they receive of light and darkness, are chiefly adapted to warn them of the depth of water safest for occupation at different parts of the day. But, however particular points of structure may be explained, the predominant interest lies in the diffusion of the same structures among the young of animals which at a later age are almost violently distinguished in size and shape and habits of life. Convergence of characters and the influence of environment seem inadequate to explain these phenomena, if we exclude the hypothesis that the crustacea which exhibit them have had a common origin and a slow evolution along many divergent lines from ancestors of very simple structure.

What is now common knowledge as to the metamorphoses of crustacea, at an earlier part of this nineteenth century was disputed by naturalists of remarkable eminence. As now and then happens in controversy, those who opposed the truth did so not out of sheer perversity or narrow-mindedness, but on the facts of observation—only not enough facts. We have noticed that a lobster leaves its egg-shell as a schizopod, and that a schizopod proper goes through many preliminary stages which are dispensed with in the hatched lobster. It is conceivable, therefore, that larval stages which are conspicuous in one set of crustaceans may be entirely dispensed with in another set. This is what really occurs in some of the land crabs and river crayfishes, and it was from these exceptional forms that the early opponents of crustacean meta-

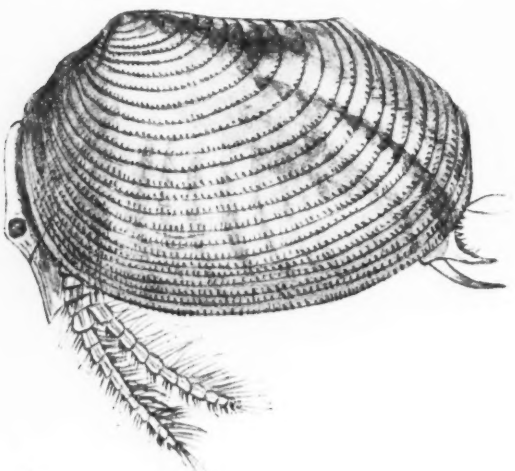
morphosis drew their conclusions. The sea being the natural and accustomed nursery of the larval forms, it has no doubt become expedient for some of the colonists of land and fresh water to have young ones which needed such a nursery as little as possible, and which in some way got over their critical transformations while still in the ovum. The latter process must have its merits, since it is adopted by the prosperous order



Estheria packardi, Brady. Nauplius.

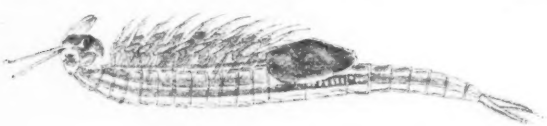
of Amphipoda wherever they happen to be born, which is generally in the sea.

The rearing of entomostraca from dried mud has enabled Professor Sars to trace very surely the development of several interesting forms. His figures here reproduced of the first larval form or Nauplius and the fully-grown female of *Estheria packardi*, Brady, from



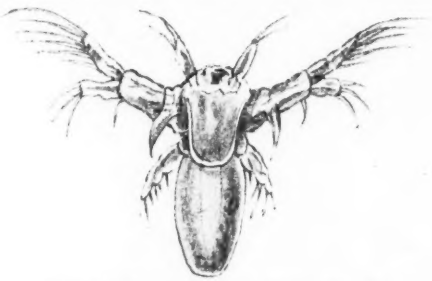
Estheria packardi, Brady. Fully-grown Female.

Australia, are worth comparing with those of his own *Branchipodopsis hodgsoni* from South Africa. The two stages being the same, it will be easily seen how nearly alike are the little nauplii, and how strangely



Branchipodopsis hodgsoni, Sars. Ovigerous Female.

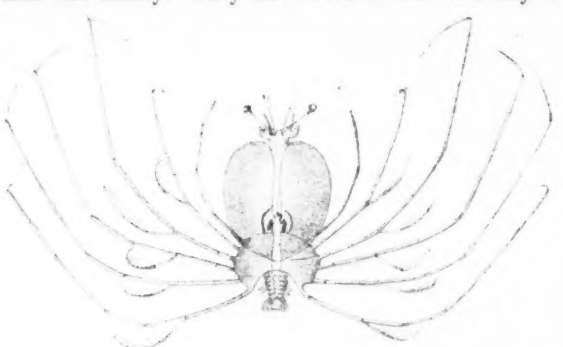
different are the adult females of these Phyllopoda. The term nauplius, now so extensively applied in the class Crustacea, has itself an interesting history. It was originally the name of a genus invented by the illustrious O. F. Müller for some tiny Copepoda. These were really the young of *Cyclops*, and their larval character had been already pointed out by Leeuwenhoek and de Geer. But they were so unlike their parents that Müller, so far from believing in any personal identity of the young and adult forms, would not allow them to belong to the same genus. It has been explained on an earlier occasion how the connection of the cirripedes with other groups of crustacea was at length established by observation of the young, the



Branchipodopsis hodgsoni, Sars. Nauplius.

parents having carried out such extensive and eccentric transmutations that for ages they forfeited the honour of belonging to the karkinokosm.

There is still one group of juvenile forms which must not be passed over in silence. With it we may fitly conclude our discursive story of the class Crustacea. The group in question goes for the present under the designation of *Phyllosoma*, a generic name meaning leaf-body. But these laminar organisms doubtless belong not to a single genus, but are the young of many species distributed over several genera in more than one family. They have even to our own day a



Phyllosoma laticorne, Leach. Giant Scyllarid larva from New Guinea, with limbs more than five inches long. Reduced from Guerin's figure in the Crustacea of the voyage of "La Coquille."

charm of mystery clinging around them, in that we do not too well know their parents, only we know that their parentage is noble. They are not the young of insignificant creatures, but of macrurans built in the grand style, the giant crawfishes and the mother-lobsters, in other words, of the Palinuridæ and the Scyllaridæ. To be sure, in these at maturity, and in the latter family especially, there is more size and substance than attractive elegance of form. But the difference between crabbed age and youth, acting as a foil, by contrast serves to enhance the delicate beauty of the Phyllosoma. Although not gorgeous in colouring, and not

tricked out in wondrous plumes, the Phyllosoma group may challenge all the crustacea of the world to surpass them in their virgin grace, and defy the glassworkers of Venice and Murano to emulate the engaging tenderness of their exquisite fabric.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor ALFRED C. HADDON, M.A., SC.D., F.R.S.

VI.—THE REVOLUTION EFFECTED BY CORN.

IN a straight line from Acre, after passing the Jordan, and the two ranges of mountains that enclose it, the traveller enters upon an immense plain, which extends to the Euphrates and Tigris. Only that portion of this plain that is nearest to the Jordan is cultivated, this is the country of the Haurân; beyond this and as far as the Euphrates it is merely a vast steppe.

The country of the Haurân, being immediately contiguous to the steppe, its population, like the Bashkirs, are peasants evolved from pastors, and it has from time immemorial been influenced by the great current of pastors traversing the steppes of Syria and Arabia.

This country is not easily cultivated, for it is not easily irrigable. Syria and the neighbourng districts are subject to a continuous dryness, owing to the prevalent winds blowing from the deserts of Sahara on the one hand, and those of Central Asia on the other. During the whole of the summer the sky is cloudless. Asia Minor, with an area five times that of France, has a volume of river-water scarcely exceeding that of France. No mountains are raised above the snow limit; scarcely has snow fallen than it is evaporated in the pure air or melting it gives rise to devastating torrents. The snow, unlike that of the Alps or Pyrenees, is not locked up to be slowly melted for the irrigation of the low-lying lands in spring and summer, but it is completely lost for cultivation.

How is it that under such unfavourable conditions these people have been constrained to transform themselves into agriculturists?

This region was formerly the sole route between the extreme East and the Mediterranean. All the merchandise exchanged between China, India, Persia, Assyria, and Arabia on the one side, and the peoples of the basin of the Mediterranean on the other, had to pass by here—it was a very cross-roads of peoples. Very numerous towns arose not only on the banks of the Tigris and Euphrates, like Babylon and Ninevah, but throughout Syria and Phœnicia, like Tyre and Sidon, and even in the middle of the desert, like Palmyra. For commerce can only be carried on in urban centres.

The development of towns by the agglomeration of the population necessitated a more intense production than that of the steppe. This was the constraint, the irresistible interest, which forced these people to agriculture. They were able to accomplish this evolution despite the obstacle of the dryness of the climate, thanks to the financial resources supplied by commerce. A very costly system of irrigation was created to supply the natural deficiency of water; the extent of the ruins of these aqueducts to-day astonish travellers. When commerce declined in this part of the world, or rather when it took another direction, there were no longer the necessary means for keeping up this complicated system of irrigation, and the town and fields were ruined, and the steppe recovered the greater part of the soil. In regions where irrigation was more easy cultivation was maintained, but with great difficulty and in a precarious manner, by utilizing the ancient canals. Such was the case of the Haurân.

The chief town of the Haurân is Busra or Bosira, the Bosra of the Bible; as the capital of Roman Arabia it acquired great importance in the Græco-Roman period. The decadence of its commerce commenced with the Musulman invasion of Syria. Still flourishing at the time of the Khalifs, it was successively ruined in the 12th century by a volcanic outburst, in the 14th century by the conquerors who ravaged Asia, and later by periodic incursions of nomad Arabs. To-day the ruins of Busra occupy an extent of 1235 acres, and support a population of 300 Musulman inhabitants.

The cultivation of corn results in a social revolution. Corn, next to milk, is the most perfect food-stuff, but the nutriment is contained in a smaller volume. This concentration of nutriment permits of great accumulations of people, as it gives in a small space the means of feeding a considerable population, whilst men nourished on milk are obliged to disperse themselves over vast spaces.

Two very important characteristics of corn are that it allows—(1) Great facility for storage. There is no comparison between the preservation of corn and that of milk, fish, or game. Thus the pastor, the fisher, and the hunter have by no means the same facility for creating riches and for accumulating the proceeds of their special industry. No food is so readily stored as corn, witness the famous granaries of Egypt, China, Italy, etc. This facility for accumulation permits provident people to possess themselves of considerable resources, since they are not obliged to consume their harvest within a short period. They can thus capitalise their products. (2) Great facility for exchange. Corn not only preserves easily, but it is infinitely divisible and travels well. The provident can utilise it for exchange, and by commerce can become rich. It is worth while to consider the immense effect of corn in history, Egypt having regular harvests, though situated between two deserts. The growing power of Russia and the Odessa corn market, and the enormous cornfields of North America.

The cultivation of corn necessitates a much longer and more difficult labour than that of garden produce. Wheat and maize especially require good soil and manure; care must be taken to select the best time for harvesting, lest the corn should get too ripe, and the weather must be carefully watched. The harvest must be got in rapidly, consequently outside help must be called in. All these difficulties and complications necessitate foresight, skill, and promptitude.

Corn also develops and complicates methods of fabrication and transport. The product, like rice, is not usually consumed in the state in which it is gathered. First the grain has to be winnowed. This is not a matter of small importance, and according as it is well or badly done so will be a corresponding difference in the return. It is a very laborious process. The four chief methods are:—(1) Threshing with a flail; (2) trampling by horses; (3) husking by pressure of a wheel drawn by cattle or horses; (4) the threshing machine. The third is the system employed by the Haurân. The family described by Le Play employed not less than ten pairs of oxen, as much for threshing as for ploughing; 1192 days' work of men and animals were occupied in ploughing, and 552 in threshing.

Corn has to be ground to flour. The heavy labour of the hand-mill everywhere falls naturally to the lot of

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women. As flour does not keep so well as corn it is better to grind it when it is required. In the household of Odysseus "at these hand-mills twelve women in all were wont to bestir themselves making meal of barley and of wheat, the marrow of men," and we find it termed "cruel toil to grind the barley-meal." Le Play cites a family of Russian peasants, composed of twelve persons, where the young women are obliged, in order to satisfy the needs of the community, to devote each year 100 days of labour at grinding cereals.

The flour has to be kneaded and then cooked, also heavy work that has to be done by the women, for it is only when there is an agglomeration of people that it becomes a distinct industry practised by men. Truly is bread gained by the sweat of the brow. No wonder that constraint is necessary to make pastoral peoples devote themselves to agriculture.

Agriculture requires numerous buildings and new implements. The fixed house, hay-loft, stable, cattle-sheds, which horticulture impose, no longer suffice. There is now required a barn, threshing-floor, hand-, water-, or wind-mills, kneading trough, oven, vehicles, and granaries. Compare the vast extent of prairies and small amount of gear requisite for a pastoral people, or the large acreage and small population required by a grazing farm with the buildings and equipment of an agricultural farm.

The cultivation of corn leads to an important development of transport. To make the most of every precious minute at harvesting there should be good roads; but the maintenance of roads is always a difficulty, thus in the Haurân corn is usually transported on the backs of animals in sacks made by the Beduin women of wool and goats' hair. A family that harvests ten tons of corn employs in order to transport it 120 days' work of men and 1640 days' work of beasts. The corn has to be carried from the fields to the granaries, and thence to the markets of Damascus or Acre.

This mode of life forces the families to be completely sedentary. The peasants of the Haurân still have numerous flocks, as they are on the confines of the steppes; but they do not graze them themselves, they confide them to the neighbouring Arabs, who still remain nomads. It is not without regret that they definitely renounce the pastoral life. The great Arab families settled on their lands or on Syrian towns glory in their descent from tribes still nomadic. They send their adult sons to pass several years with these tribes, in order to gain prestige.

Property in land tends to become more and more permanent as cultivation increases. As the available land is so extensive the family from year to year can put new land under cultivation. Tacitus tells us that the ancient Germans were in precisely the same condition.

The traditions of the former nomad life are very noticeable in the character and limitation of the household utensils. The furniture of the rooms is confined to some boxes and chests in which are the valuables and the mattresses and rugs. The hearth is small and portable; butter, milk, and water are kept in goat-skins.

The cultivation of corn tends to limit the number of proprietors. Agriculture by becoming prolonged, more complicated, and more expensive, requires more exceptional capacities. In these societies, where external government rarely intervenes to protect the people against the attacks to which they are exposed on the part of their nomadic neighbours, it is to everyone's interest to form part of the community. Hence the incapable are absorbed by the capable—they enter into their families. These new members are not servants, they are associates, and form part of the community. They are treated as members of the family, and may marry a daughter of the house, in which case they need not pay a dowry.

The cultivation of corn does not necessarily modify the organisation of the family, it remains patriarchal. The greatest difficulty that can arise is when the family grows too big for the resources of the land; but this does not affect the peasants of the Haurân.

Trade develops. Corn is a product easy to accumulate and exchange. The families readily acquire the habit of selling their surplus and of purchasing food and other things. Thus the families of the Haurân begin to buy at Damascus and elsewhere, rice, which they eat as a treat, olive oil, various legumes which do not grow in their country, spices, sugar, coffee, etc., wooden boxes, some earthenware or iron pots, various household utensils, a few books, especially copies of the Koran, ink, pens, and paper. What a transformation has occurred from the pastoral life. The families content themselves less and less with what they produce themselves; they become partly dependent upon merchants, they are subject to the fluctuations of the market. The buying of books and of writing materials is a sign of another important modification.

Intellectual studies are developing and the teaching takes place more and more outside the family. Agricultural families feel the need of certain elementary knowledge such as reading, writing, and arithmetic, especially in relation with their trade. How for want of a little elementary knowledge the Mongols are fleeced by the Chinese traders!

Among the Haurân, unlike the Bashkirs, the functions of the schoolmaster are separated from those of the priest, a further step in specialisation. The scholastic organisation is still quite rudimentary. When, in a village of Haurân, a certain number of young men wish to learn to read and write, a teacher is procured from Damascus. Thus in each community there is usually at least one person who can read, write, and cipher. The peripatetic instructor of the Haurân and the settled teacher of the Bashkirs are the two types which persist through all societies. It is characteristic that they learn to read the Koran, and the instruction is always exclusively religious. Where the idea of the family predominates and the spirit of tradition reigns, instruction is confined to domestic and traditional religion. They fortify one another.

The sedentary life brings into contact families professing different religions. In the Haurân, Greek and Roman Christians live side by side with the Musulmans who form the bulk of the population, and who are tolerant in their relations with Christians. This tolerance is due to the patriarchal habit. Religion is almost solely a family affair. Public religion does not exist, there are no Musulman clergy. The sanctity of each family is respected.

The complications of neighbourhood mainly arise from antagonism between the nomads and the sedentary; partly a question of superiority, partly due to the encroachment of cultivation upon the steppe. The pastors make raids upon reclaimed land. The peasants of Busra are obliged each evening to drive their cattle into an immense fort, built at the time of the Khalifs for this same purpose.

It is interesting to note how the public executive

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arises in a population which the Turkish Government is powerless to protect. The defenders of the public peace are the very people who menace it. Each year every sheik has to make treaties with the various nomad tribes in his vicinity, and engages to pay a tax called *el khui*, "the brotherhood," the tribe thus becomes "the sister," *el ukta*, of the village. The sheik of the tribe undertakes to respect the harvests, flocks, and possessions of the peasants. The tax varies every year. The inhabitants of Busra pay about £125 annually to seven tribes. It was thus the Romans acted in regard to the barbarians when they could not repel them; they assigned territories to them upon the frontiers, paid them a tax, set them against other barbarians, and disguised this impotence by describing them under the pompous title of "Friends and Allies of the Roman People."

These series of articles may be concluded by giving M. E. Demolins' summary of the social revolution accomplished by agriculture:—

Corn is the necessary element for large agglomerations of men, for complicated societies.
It develops commerce and riches.
It modifies and complicates the conditions of cultivation.
It develops manufactures and transport.
It imposes on women their hardest work.
It transforms horses from steeds into beasts of burden and draught.
It brings about the complete substitution of a sedentary life for a nomad existence.
It renders the appropriation of the soil more permanent.
It further tends to restrict the number of proprietors.
If it does not essentially modify the patriarchal family it makes its working more difficult, and leads to a selection among the heads of families.
It causes the families to be less necessarily self-sufficing and to be more dependent on commerce.
It develops intellectual culture.
It brings about a more frequent and intimate contact between families belonging to different beliefs and admits of the contact of dissidents.
It complicates the relations of neighbourhood by bringing residents and nomads face to face.
Lastly, it necessitates a greater development of government.

THE HEART OF DAUPHINÉ.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

THE traveller may leave the busy line that thunders with the trains from Paris to Turin, may step into the Piedmont highlands at the little station of Oulx, and there, doubting if he is in France or Italy, may walk up ten miles to the *col* at Mont-Genèvre. The road climbs above the vegetation of the valley, high upon the talus of the hills; the rocks rise in crags and pinnacles, the outposts of a weird and broken region to the south, where the cañons lie brown and bare below him, like a scene in rainless Colorado. But at the pass he finds the patch of Alpine meadows, the châlets with their overhanging eaves, and the little inn with that hospitable inscription, a true motto of the frontier, "Le soleil luit pour tout le monde." On his left stands Fort Janus, grim upon its limestone crag; but his eyes look beyond it, to where, in the west, a serrated mass of snow-peaks towers in the middle air.

The stranger thinks of his map of Europe, but still asks himself, "What are these?" If he is one of the few thousands who honestly believe Mont Blanc to be in Switzerland, he is all the more surprised and fascinated. He is facing France, a land of plains and plateaux; what are these giants that arise and bar his progress?

We are, in fact, nearing the granite knot of Dauphiné, that self-contained group of Alpine summits known as the *massif* of the Pelvoux. It is an incident on the great curve of the Western Alps, which runs from Nice to Chamonix; the Grandes Rousses, the mountains of Modane, the Grande Sassière, and the Ruitor, all traversing the snow-line, connect the Pelvoux with the *massif* of Mont Blanc. The axis of the range then bends eastward, giving us the Matterhorn and Monte Rosa.

The summits of the Pelvoux are by no means to be despised. Some, at least, of our own climbers have made their mark upon them, and the fact is recorded by the "abri Tuckett" and the "Pic Coolidge" on the maps of the French Government.* La Barre des Ecrins, with its 4103 metres (13,460 feet), the beautiful peak of the Meije† (3987 metres), the Pelvoux itself (3954 metres), give us some idea of the dignity of the mass. Like most of the giants of the Alpine chain, these owe their prominence to the intrusive granite which has consolidated the mountain core, binding together the old schists into which it penetrates, and weathering out ultimately into pink-brown pinnacles and spires.

We see something of the inner structure of the *massif*, if, approaching it from the west, we leave the stratified hillsides of Bourg-d'Oisans, and enter the first grim ravine. The *route nationale* from Grenoble to Briançon here attacks the mountains by the deep channel of the Romanche. The huge precipices give us sections that are more convincing than the clearest diagrams of a lecture-room. The schists and gneisses are seen to be traversed by pale veins of granite and aplite.‡ Many of the old rocks may have been crystalline at the time of this intrusion; but the intimate penetration of the granite among them has converted many of the milder types also into gneiss. The white veins of the invader, conspicuous on the cliff that rises from the torrent, form bands many feet across; the fragments that may be picked up from the surface of the road show the same features in miniature, and bear witness to the completeness of the intermingling. Wherever the schists are thus seamed with igneous matter rich in silica, the main mass of the Pelvoux granite lies at no great distance from us.

We look up, and see green meadows, and the remote hamlet of Auris, occupying the very summit of the cliff. Here the Mesozoic strata lie across the upturned edges of the schists; and patches and infolds of them, Trias and Lias for the most part, occur even in the *massif* of the Pelvoux. Though attained only by zig-zag mule-

* Coolidge, *Alpine Journal*, Vol. V., p. 128; Vol. VII., p. 136; Vol. IX., p. 121; F. Gardiner, *ibid.*, Vol. VII., p. 80.

† First climbed by M. Castlenau; see *Alpine Journal*, Vol. VIII., p. 328. On its difficulties and general characters, see H. G. Gotch, *ibid.*, Vol. VIII., p. 177.

‡ Compare W. Kilian, "Alpes du Dauphiné et Mont Blanc," p. 22, and M. P. Termier, "Massif du Pelvoux et Briançonnais, pp. 12, 21, &c. (Livret-guide des excursions en France du viiie. congrès geol. internat., 1900).

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tracks, these valued relics are eagerly seized on by the peasantry. It must be a source of much annoyance to know that the great snow-field of Mont-de-Lans covers similar stratified rocks, which have been raised too high even for the industry of a Frenchman.

The road that we have selected climbs onward to La Grave in a valley of impressive barrenness. The gorge of Gondo on the Simplon Pass possesses many similar features; but here the continuous rock, the jutting spurs without a sign of vegetation, the huge fallen rocks, unsoftened by moss and even unflecked by lichens, force on us a growing sense of desolation. Nothing now remains, as we leave the hamlet of Le Dauphin, but schist and granite, the mica gleaming on the fractured surfaces, the white veins, cold and dead, making streaks upon the great rock-walls. High up on the right, three or four little tongues of ice creep over from the unseen plateau; in front of us, a huge bare crag glows crimson, answering the sun that already has set beyond Grenoble. Then the darkness grows; the cliffs become black, save for the foaming bands of half-seen water-slides and falls; we push through lengthy tunnels, and both hear and feel the moisture dripping through the clefts; then we emerge again, as from a tomb, into a world where nothing seems alive.

Suddenly this world changes; the edges of the ice above us become, as it were, translucent, tinged with a green light from behind; on our left, the upper half of the precipices stands out, every crag and scar revealed; while across our path, and on the nearer taluses, the blackness seems to deepen, for we are still far down in the ravine, lost in the shadow of the Pelvoux. But the moon is rising, full and clear across the snows; already the light-shafts cross the valley, borne upon the tiny globules of the mist, which is too thin to be otherwise apparent; the triangular dark spaces left between these luminous bars are the air-shadows of the unseen crests.

Mile by mile, we near the close of the ravine, where a series of overfolded and repeated Mesozoic strata forms a grass-clad region, leading away to the Col du Lautaret, 2075 metres (6806 feet) above the sea. Near the hospitable village of La Grave,§ the peaks of the granite mass come into view upon the right; the moon seems poised for a moment on the very summit of the Meije, her disc intensely brilliant in the blue-black of an Alpine sky. The great snow-basins, and the glaciers oozing from them, form mysterious white masses, clinging to the highest slopes. The long Combe de Malaval is over, and the heart of Dauphiné is gained.

Next morning, in the cloudless sunlight, we can appreciate the contrast between the Jurassic strata of this pastoral upland and the granite mass of the high Alps. The former consist largely of dark and shining shales, with intercalated bands of limestone; where they are squeezed up almost to the snow-line, they appear coal-black under the white fields and the translucent masses of the ice. The storms of rain, intense at these high altitudes, have carved gullies in them, irrespective of their bedding, much like the channels cut in soft clay at ordinary levels. Above them, the granite forms a number of peaks, which long defied the climbers, with flanking *aiguilles*, such as one sees on the *massif* of Mont Blanc.

While the Mont Blanc range is an elongated mass of granite, penetrating the schists, absorbing and including them, and exposed over a distance of 40 kilometres, the Pelvoux mass is an almost circular knot, 15 to 20 kilometres across, and perhaps only the crest of a far larger subterranean dome. In both cases, the granite has been brought to light by the movements that culminated in Miocene times, while Jurassic strata have been caught up on the flanks in the form of deep or recumbent synclinals, formed during the crumpling of the rocks that lay below.‖

The ascent to the Col du Lautaret from La Grave thus shows us, far below upon our right, a valley worn in the softer rocks, extending far into the *massif*, and then closed abruptly against the broad Glacier of Arsine. A stream, the upper part of the Romanche, has laid hold of this weak band of overfolded strata, and has produced a valley 3000 feet in depth. The products of erosion are thrown out in a pretty delta against the meadows of Villar d'Arène. The granite on the east side of this Mesozoic infold is forced up by the earth-pressures until it overlies the Trias, which in turn rests on Liassic limestone; we now know that such inversions of the natural order are a frequent feature of mountain-chains. This deep synclinal between two granite masses, forming the upper valley of the Romanche, has its counterpart in the glorious Allée Blanche under the Italian aiguilles of Mont Blanc.

To the east of the Col du Lautaret, the characters of the Alpine foot-hills reappear. The brown limestone crag of the Grand Galibier reminds us of Tyrol; the mountains about the fortress of Briançon, to which we now descend, have their counterparts in the southern Juras. A band of Coal-Measures comes up in their midst, much broken and displaced; it is the same as that which contains beds of graphite on the Little St. Bernard, and which can be traced north-eastward right into the valley of the Rhône.

We now join the Durance, one of the most vehement of Alpine streams. The whole region bears witness to disastrous denudation. A few wet days in August of the present year converted it in places into a mere wilderness of stones. Already, as we come down from the Lautaret, we find one of the long tunnels broken into by a stream, and choked with *débris* from the mountains. A little further on, when we have traversed the rough track constructed on the outside of the tunnel, we find huge blocks deposited on the crown of a bridge, which has naturally given way beneath them. The former stream-hollow has, however, become filled by a land-slide, and is thus not difficult to cross. Down below Briançon, similar havoc has been wrought on the surface of the broad detrital cones, which everywhere mark the entry of the lateral streams on the main valley of the Durance. The villages, like those of Karinthia, are commonly built on the summit of these cones, which spread out, in huge shifting fans, on either side of their main axes. Wooden groins, like those set to control the movements of sea-beaches, are constructed in the more dangerous portions of the cones; here and there, the movement of the surface has broken them across, while the pebbles have poured through and over them like a flood. The country is one in which denudation can be felt; the very fields of the peasantry may disappear into the Durance, or may be buried in an hour beneath an oozing stream of stones.

The older alluvium of the valley, in which ravines have been carved by the modern action of the streams, still projects in patches from the mountain-walls; many of these masses of mud and gravel are the relics of ancient and majestic land-slides. The road has to be

§ Very different from the La Grave described by explorers thirty years ago.

‖ Termier, *op cit.*, p. 20.

cut along vertical cliffs of what seems the most treacherous material, until it can find a firmer hold on the Jurassic or Cretaceous rock beyond.

Some of the old pebbly alluvium, however, has become consolidated as a firm conglomerate, brown and massive, breaking now into huge rectangular blocks. It is difficult to believe that this rock is of about the same age as our glacial gravels in the British Isles. It forms solid platforms in the valley, on one of which the town of Embrun stands; on another, still more imposing, the fortress of Mont Dauphin has been piled. This conglomerate has its analogue in the beds that once choked the Alpine streams, as they emerged on Bavaria¶ or on the plain of Italy.

The decay of Dauphiné under the tremendous battery of its storms is aided by the nature of the Mesozoic rocks themselves. All down the valley of the Durance, a large part of these consist of black shales, nearly as hard as slate, which yet crumble up into mere flaky powder when exposed. In these beds, the occasional thin bands of yellowish limestone alone mark the stratification. Being much contorted, they run like conventional streaks of lightning across the uniform blackness of the shales, surprising us again and again by their evidence of the original structure of the mass. In between them, and often involving them in decay, the shale weathers down like a mere rubbish-heap exposed to the wash of rain. Characteristic little cirques are worked out, by the union of the rivulets that occur during storms and rapidly die away again. Each group of these rivulets terminates in a common channel below, and the rock-mass between two adjacent channels in time comes to stand out like a steep conical earth-pillar or bluff. Whole hillsides are cut up into these pillars or earth-pyramids, as if the material was some superficial moraine, instead of the rock that builds the mountains. Probably, the alternations of storm and intense sunlight—for we are here on the latitude of Florence—have much to do with the rapidity and uniformity of disintegration. Compact shales, that in our insular climate might weather out almost like the slates of Moelwyn, are here doomed to destruction before our eyes. The pyramidal or steepy conical forms due to denudation become fascinating, and at the same time monotonous. In the wild ravine from Savines down to Espinasses, we lose sight of them with pleasure; limestone here predominates in the Jurassic series, and sheer rock-walls and terrace-structures are the result. But, at the further end, the fantastic forms return to us like an evil dream; at times the outer sides of the bluffs become rounded, resembling badly made columns, or the swollen trunks of trees. A vision of elephantiasis presents itself; whole mountains appear to be abnormally diseased. The rotten condition of the surface is seen when one of the larger side-streams cuts its way down to the Durance; the ravine made by it in the black strata repeats the characters of those carved in loose alluvium.

This valley of the Durance provides, indeed, an amazing picture of destruction. We begin to ask ourselves, what is solid, what is proof against the thunderstorm that crashes through the mountains, or against the dry heat, the glare of southern sunlight, that strikes up towards us from Provence? The enormous cliffs of massive limestone that at last rise around us, pale and ghostly in the blackness of the storm, may give us some assurance; they bring south, as a bulwark to Dauphiné, the finest features of the Juras. But our impressions of the Durance, down to the delta-formations among the almond-orchards of Manosque, are those of a stream pillaging a country. The dust that forms on the disintegrating surfaces in days of burning sunshine spreads itself to the leaves of the vines and to the grass of shadeless fields. Even the tiled roofs of the villages have caught the prevailing dust-colour, a uniform tone of yellow earth. The bastide of Montfort is yellow on its yellow hill; the hamlets along the mountain-spurs conceal themselves successfully, by mimicry of the stone-heaps from which they rose. These contrasts between the crumbling foothills and the old Alpine core which has become pre-eminent by their decay are nowhere more brilliantly revealed than here on the outskirts of Provence. For always behind us we may catch some glimpse of the granite heart of Dauphiné; beyond the long valley, and the ruin of its walls, lies the glory of the high alp and the snows.

¶ *See* KNOWLEDGE, Vol. XXIII., p. 123.

THE MILKY WAY IN CYGNUS.

By Mrs. WALTER MAUNDER.

THE accompanying photograph was taken in the second week of August, 1899, during the progress of the Perseid shower. The photographic object glass used was a Dallmeyer stigmatic lens of 1½ inches aperture and 9 inches focal length. The size of the plate is that standardized by the International Astrographic Chart, namely, 16 centimetres square, so that the area of the sky covered is about 1400°. The camera was mounted on an equatorial stand, constructed by the late Mr. Sydney Waters, F.R.A.S., for use in eclipse observation, and bequeathed by him to the Royal Astronomical Society, by whom it was lent to my husband. It was housed in a small wooden observatory, made with a roof that could slide quite away and leave as much sky room available as the other conditions of the situation allowed. This was not very great, as the garden in which the observatory was placed was small, and much surrounded by houses, which not only limited the horizon, but abounded with windows that were unpleasantly illuminated at night.

The photograph was exposed for 6½ hours, but the exposure was distributed over several nights, and this for various reasons. In the first place, the equatorial was of the "German" form, *i.e.*, there was a counterpoise to balance the camera at the other end of the declination axis. Consequently either the camera or the counterpoise would foul the stand shortly after passing the meridian, and the instrument would have to be "reversed" in order to continue to follow the stars. This would also mean reversing the relative positions of the stars in the telescope, which in visual work would not matter, since the eye does not retain on the retina the first positions of the stars, but which in the camera would introduce new and unknown configurations of stars on the plate. And the exposure must not take place whilst the guiding star is very far distant from its meridian, since its altitude is then rapidly changing, and the area covered by the plate being very considerable the effect of refraction would vary largely over the plate, and be, moreover, variable in its change. Thirdly, and this was by no means the least important factor, the strain on the observer was very great. The guiding telescope was a Cooke refractor of 2½ inches aperture, small but of excellent quality; the diffraction rings round the brighter stars were many and almost perfect. There were absolutely no luxuries in the shape of illumination of field or wires, not to speak of electric control to the driving clock; the observer had to be

her own automatic control, and to this the strain of long continued observing was largely due. The substitute for field illumination was simplicity itself; in the eyepiece were four crosswires, and the brightest star available in the region was selected as the guiding star. The eyepiece was drawn out so as to put the star out of focus, and the spurious disk thus formed was quadrisected by the crosswires—and kept quadrisected. Of course this was supposed to be the clock's business, but here lay the great source of disaster. If the spurious star disk was not kept quite steadily on the intersecting wires, but wandered off them, then the black wires became invisible against the black sky, and all sorts of hieroglyphics might be drawn on the plate by the frantic star before the intersection was found again. The driving clock is a very valued friend, but his great value and assistance cannot blind me to his idiosyncrasies and failings, among which may be numbered a wearying in well-doing that is more than occasional. He was originally built to run for the short period that totality lasts in a total eclipse of the sun, and not for the hours that may be necessary in taking a star photograph. When he had been running for some time, and had been wound up two or three times, and was in a very good temper, I might venture to leave him to go alone for a period not exceeding 60 seconds. Twice, indeed, I have left him to his own devices for a space of time nearly five times that, but that proved to be a very rash action.

The observer's duty, therefore, was to sit as comfortably as the position allowed with one eye glued to the eyepiece, the declination slow-motion rod in the left hand and the right hand touching the slow-motion wheel of the right ascension circle. The best results were generally obtained when a direct connection seemed to be made between the eye and hand, and the connections between these and the brain apparently switched off. Usually it was fatal if I thought of what I was doing; it was much better to think of something else—something not exciting.

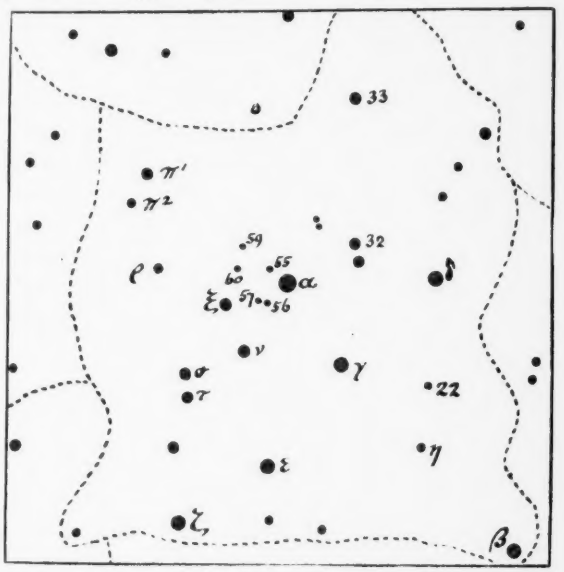
In the photograph under consideration no perceptible error in driving is to be seen; the guiding star is perfectly round, and so are the stars situated within ten degrees of the centre. During the exposure I saw many of "The Tears of St. Lawrence." I hoped that some would pass across the field of my camera, but I saw none within that region, and none have been impressed on the plate.

The photograph was taken for the purpose of studying the form and structure of the Milky Way, which may be seen crossing the plate diagonally, and is well shown throughout its greatest width. Much detail is seen on the original negative that is unavoidably lost in a process reproduction. The description is drawn from the original negative, and therefore some of the structures pointed out may not be recognisable on the accompanying Plate.

The scale of the original negative is almost exactly that of Cottam's smaller Star Charts, and the field photographed corresponds almost precisely to Chart No. 22, the constellation Cygnus.

The key-map, showing the brighter stars in the central region, is traced from the negative, but the magnitudes assigned are those of Proctor. As it will be at once seen these are very different from the photographic magnitudes, as might indeed be expected in such an actinic region as the Milky Way.

The large central star, which was used as a guide, is α Cygni, and is situated in a gap, or what might by courtesy be termed a gap, in the Milky Way. The great star belt itself seems to be divided into five fairly distinct regions. The preceding one of these is roughly crescent-shaped, with 33 Cygni and 22 Cygni in the northern and southern horns respectively, and 32, δ, γ and α Cygni lying on its borders. A small



The Constellation Cygnus. Key-map to Plate.

horn, having its base resting on the stars 32 and δ Cygni, appears to point in a north-westerly direction. The whole of this region appears to be covered by a diffuse, but not uniform, faint cloud, which gives the appearance of nebulosity, but which under the microscope is seen to be, not nebulosity, but faint, fairly well defined stars. γ lies on the western border of another region, smaller but more striking, since not only are the faint stars aggregated so as to suggest a nebulous bed, but brighter stars are also massed together, giving the appearance of numerous and superimposed layers of stars whose brightness diminishes with their distance from us. More to the east again there is a huge region, not seeming to differ in its composition (as far as this negative can tell) from the two regions already mentioned, except in the greater frequency of its local aggregations of both bright and faint stars, and in its more numerous channels where no stars appear or only a few sporadic ones. Such a channel, long and well-marked, separates this region (which contains the stars π^1 and π^2, ρ, ν, and ε Cygni) from another, a fainter one, and parallel to the first, still further to the east.

But the most marked and interesting region of all, is a small one on whose western border α Cygni lies, and which contains the stars 55, 56, 57, 59, and 60. To the unassisted eye this region appears on the negative to consist of a dense nebulous patch, intersected by extremely fine streaks. Under the magnifier, the nebulosity *to some extent* resolves itself into faint and fainter streams and bands of stars, these being again bound together by still fainter bonds which are *not always* resolvable into discrete stars. The streaks are some of the spaces between the streams and unresolvable bands, where no star nor connecting stuff is seen. A most beautiful and particular instance of this is to be seen in a figure of 8, formed of lines of stars and bands, immediately following 60 Cygni, and which seems

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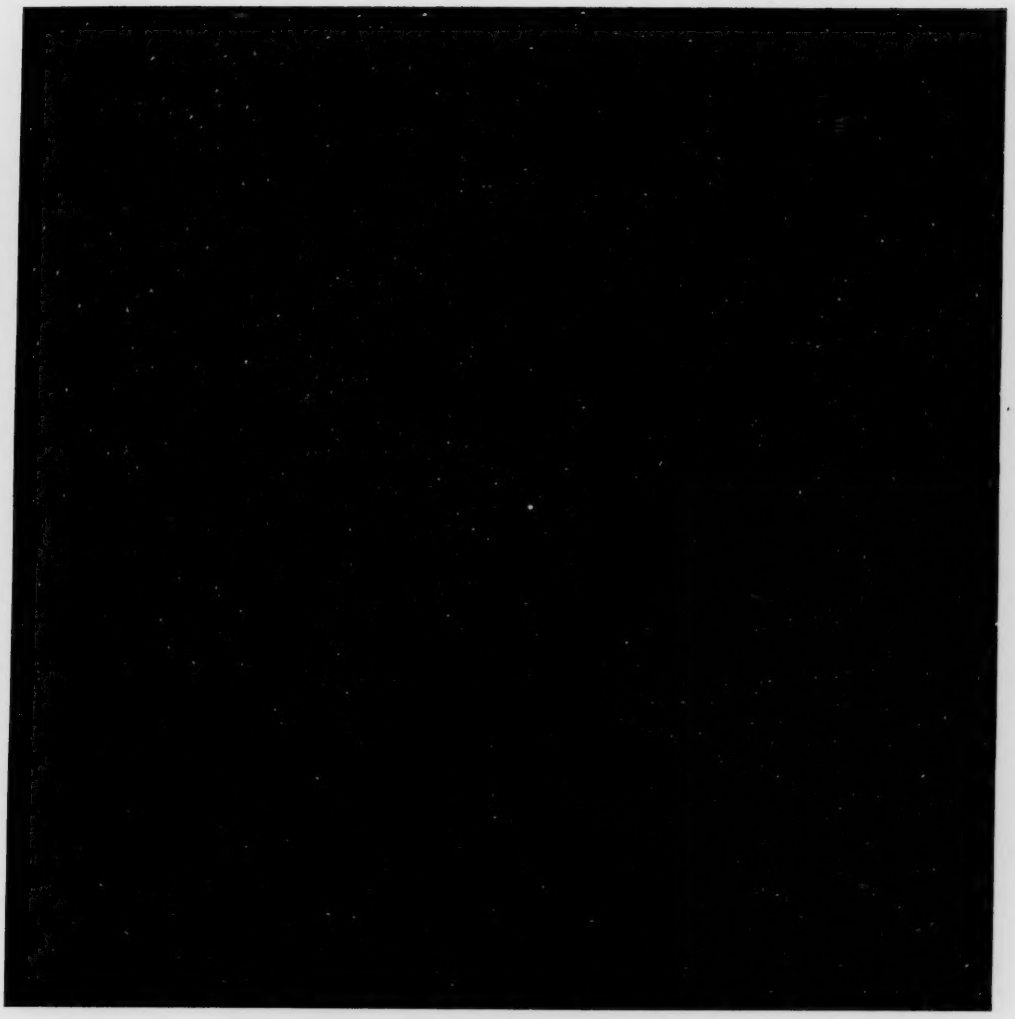
NORTH.



EAST. WEST.

SOUTH.

THE MILKY WAY IN CYGNUS.

From a Photograph taken by Mrs. WALTER MAUNDER, August, 1899, with a Dallmeyer stigmatic lens of 1½ inches aperture and 9 inches focal length.

[Field 38° side. Exposure 6½ Hours.]

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to form part of a complicated but well-defined whorl of stars.

It seems quite clear that though the general form and structure of the Milky Way in Cygnus is well shown on this plate, no true nebulosity is shown by it over its breadth, but only apparent nebulosity due to the aggregation of small discrete stars too faint to be separately perceived by the unaided eye. It is possible that true nebulosity is photographed in the region round 60 Cygni, but that cannot be decided from this photograph alone. Possibly an exposure of 13 hours might settle the question, and some of these years I shall hope to try it—if the Clerk of the Weather will some August screw the hand of his barometer to "Set Fair," and go on his summer holiday, and the moon is new; and my neighbours will go to bed early, and turn out the gas.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE "COLLINS' MONOPLANE TELESCOPE."

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The "Collins' Monoplane Telescope," described on page 252, appears to be a combination of a poor Newtonian reflector with a poor refractor. The only advantages claimed over the ordinary refractor are perfect achromatism and shortness, both which the Newtonian already possesses, without the great disadvantages of the Collins. The Newtonian requires two pieces of glass of ordinary quality, and has only two surfaces to be worked, one to a perfect curve, the other to a perfect plane, both fairly easy to test for figure, and the reflection is from surfaces of silver *not* covered with glass, and therefore brighter than any glass-covered surface, and there is no absorption of light by passing through glass.

The Collins requires two optically perfect discs of glass, of which the second must be so homogeneous that I fear practically they would be difficult to produce and exceedingly costly. If used with a silvered flat it has four glass surfaces at which light is lost, two lenses absorbing light in their substance, one of which it traverses twice, one silvered surface less reflective than in the Newtonian, and another under similar conditions as in the Newtonian. If a prism is used instead of a flat, there are six glass surfaces each taking a percentage of the light away, and the equivalent of five absorptions in the thickness of the glass. The glass surfaces have all to be worked perfect, and at least in the case of the correcting lens-mirror local correction appears to me impracticable. With ordinary refractors on a large scale, local correction is, I believe, a very important matter, and it is only on a large scale that the Collins' Monoplane's advantage of shortness would be of value.

I doubt if a good telescope of any large size could be constructed on the lines given; I doubt if it would be perfectly achromatic; and I am sure it could not equal, much less surpass, a Newtonian of the same aperture. Why then go to so much expense and trouble?

EDWIN HOLMES.

[Mr. Holmes's comdemnation of the "Monoplane" principle is far too off-hand. The idea is being made the subject of the most careful experiment and investigation, both in this country and on the Continent; and so far from dismissing it in Mr. Holmes's summary style, one of the highest authorities in practical optics in Europe is now having a large telescope constructed upon these lines.—E. WALTER MAUNDER.]

THE PHASE OF VENUS SEEN WITH THE NAKED EYE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—To see our neighbour Venus in brilliant sunshine when near her greatest elongations is, I am quite aware, nothing remarkable as a feat, but my recent experience in this connection is to myself quite unique, and its relation may prove not uninteresting to your readers. Living as I have for years past in north-west London, I have perforce had to observe sun, moon, and planets, as through the upper reaches of the dusty air of the metropolis. I have often noticed how much more transparent my air is in the month of October than it is generally at any other time of the year. Several times during the last fortnight the morning air has struck me as exceptionally clear, so much so that I remembered Venus, whose movements I had ceased to follow since her last inferior conjunction, and I determined to look her up in bright sunshine. No sooner resolved upon than accomplished. The first occasion was on the 5th instant, between 7 and 8 a.m., the sun low but brilliant. On the morning of the 14th instant I saw her again in bright sunshine at 9h. 15m., or soon after her meridian passage. At these times, as at some intermediate ones, I was chiefly interested in noting her lustre. She did not appear as a white point on a dark blue sky, but as sparkling against a rather pale blue background. Now this morning (October 15th) I observed her several times, the last occasion being as late as 9h. 50m. As before, sunshine was as plentiful as one could desire. On no adventure of this kind have I employed any aid to find her—optical or mechanical. I have simply stood in the shade of the meteorological instrument screen. Very well, then, to-day she has appeared as a small white *disc*—spurious, of course. Until about an hour ago I did not know that Venus had passed her greatest western elongation—in fact I did not think she had; hence I adjudged her a phase about equal to that of a six days old moon. But I see by the *Nautical Almanack* this evening that on this identical day 0·637 of her disc is illuminated, and this is where the curiosity enters. Her angular diameter is about 18·4″, and her distance from the earth this morning was something like 84,894,000 miles. It is laid down as a physiological fact that the smallest object to which unassisted human vision can assign a definite shape must subtend an angle of about one minute of arc. A bright point is an entirely different matter. Now I know my own sight is by no means marvellously sharp, so that I am greatly puzzled to know how the illusion of the disc originated; because, as to illumination—we see nothing at all if there is no light to see it by. It may be that the spurious disc of a star in a telescope offers an explanation; in fact, I was satisfied to accept that as such before I found this evening that nearly two-thirds of the planet's disc was illuminated this morning. But now the question arises: is it in any circumstances possible that a body subtending so small an angle could be seen to possess a definite shape, or how in such a case is the illusion—if such it be—caused? I may add my eyes seem purely emmetropic, and whilst on the one hand there is no suspicion of myopia, on the other there is nothing miraculous about them.

WILLIAM GODDEN.

38, Burrard Road,
West Hampstead, N.W.,
15th October, 1900.

"DARK MARKINGS IN THE SOLAR CORONA."

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In reading Mr. Wesley's admirable article on the "Dark Markings in the Solar Corona" (KNOWLEDGE,

October, 1900), it occurred to me that these markings may be due to the presence of dense swarms of meteoric bodies near the sun. The markings of the coronas of 1871 and 1900 seem to me to favour this view. The passage of a dense swarm of meteorites between us and the corona would, I think, show us a dark mark; but the question is, Would the markings be as dense as those described by Mr. Wesley? H. W.

Middlesbrough,
October 24th, 1900.

[H. W.'s suggestion is an obvious one; but is open to the objection that, in that case, we ought sometimes to see dark lines due to meteor-swarms projected against the disk of the sun; which we do not.—E. WALTER MAUNDER.]

RAINBOW PHENOMENA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—On the evening of September 16th, a remarkably vivid double rainbow was visible at Eastbourne from 5.30 till after 6 o'clock, and its magnificent colours must have attracted the attention of many observers.

A curious phenomena was conspicuous on the inner or violet edge of the primary bow.

I have noticed on previous occasions that in the case of brilliant rainbows the violet rays frequently reappear as a distinct band within the primary bow, and separated from it by a moderately wide unilluminated strip.

But in the case under notice the phenomenon was intensified to a remarkable degree, the violet band being clearly triple, and the inner edge of the primary bow exhibiting the following series of colours without any apparent break—viz., green, blue, violet, green, blue, violet, green, blue, violet. Occasionally there appeared to be traces of even a fourth (isolated) band of violet; but upon this point I could not be absolutely certain.

The general effect was curiously like the mouldings on a stone archway, the inner edge of the bow presenting the appearance of concentric ridges of green separated by violet hollows.

The three continuous bands, each consisting of green, blue, and violet, were clearly seen by two others whom I questioned on the subject.

In the case of the simple repetition of the violet band, I have often attributed the appearance to an optical illusion, or even to some modification of the "ultra-violet" rays, but the complicated reduplication of the phenomenon which I witnessed last Sunday has re-awakened my interest in the subject, and I should be very grateful if any of the numerous scientific readers of KNOWLEDGE, to whom the subject may be of interest, will offer some explanation of the phenomenon which I have attempted to describe. S. R. STAWELL BROWN.

St. John's College, Oxford,
September 18, 1900.

LUNAR RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

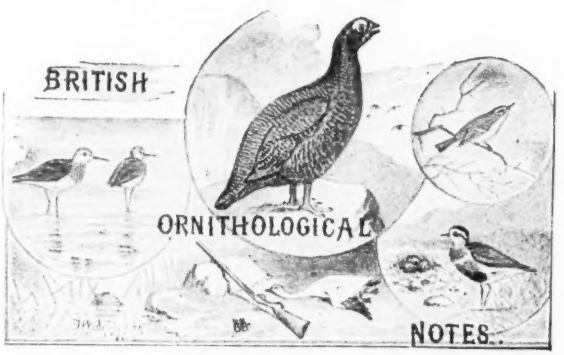
SIRS,—It seems pretty evident from the description given by Mr. John Macintosh in your November issue, that what he saw was not a lunar *rainbow* at all, but what is usually called a *corona*. The phenomenally long duration (1½ hours), the smaller diameter, and the fact that the lower portion was cut off by *clouds*, all point to this conclusion; the diameter of a lunar (or solar) rainbow is, for the primary bow, always about 82°, the lower part is always cut off by the earth (except in rare cases when the observer stands on the top of a mountain peak), and anyone who has seen a bright lunar rainbow endure for more than twenty minutes or so is fortunate indeed. The following extract from my register may interest your correspondent.

"January 31st, 1893, 9.15 p.m. Beautiful lunar corona, the inner part of a brownish orange colour, and then the colours of the spectrum in order from violet to red, most clearly defined and pure."

These coronæ are really diffraction rings, and according to Kœmtz (*Cours de Météorologie*, page 424), may have a diameter of from two to eight degrees, thus agreeing roughly with your correspondent's estimate.

Harewood Lodge, CHARLES L. BROOK.
Meltham, Huddersfield,
November 6, 1900.

THE ROYAL SOCIETY'S MEDALS have this year been adjudicated by the president and council as follows:—The Copley Medal to Professor Marcellin Berthelot, FOR.MEM.R.S., for his brilliant services to chemical science; the Rumford Medal to Professor Antoine Henri Becquerel, for his discoveries in radiation proceeding from uranium; a Royal medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Professor Alfred Newton, F.R.S., for his eminent contribution to the science of ornithology and the geographical distribution of animals; the Davy Medal to Professor Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Professor Ernst Haeckel, for his long-continued and highly-important work in zoology, all of which has been inspired by the spirit of Darwinism.



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

NESTING-BOXES FOR WILD BIRDS.—Some details respecting the nesting-boxes which I have been in the habit of providing here for wild birds may be of interest. The boxes are of two kinds, one for the use of small birds the other for large birds. The smaller boxes are ten inches high and six inches square, made of well-seasoned oak. A hole, about one-and-a-half inches in diameter, is bored in the front of the box for ingress and egress. The roof, which is sloping, is provided with leather hinges, and thus forms a heavy lid, enabling the boxes to be cleaned and the old nests taken out every year. A few small holes are pierced at the bottom of the box for draining purposes. These boxes last for many years. We have a number about that have been up from twenty-five to thirty years. They

are fixed very firmly from four to six feet above the ground against trees. They should not be exposed to the south-west, which is the worst quarter. Fixed thus near the ground and away from houses the boxes are practically never used by Sparrows. All four Tits nest in them largely, Great Tits and Blue Tits predominating. Some years nearly all the Tits using the boxes are Blue Tits, other years they are Great Tits, and a good few Cole Tits use them, but the Marsh Tits, although common here, very rarely do so. Wrynecks always use some, preferring those in open situations. They will frequently destroy a number of Tits' nests, pulling out the nests and eggs. The Tits cover up their eggs in the boxes until they begin to sit. Nuthatches also avail themselves of the boxes, mudding up the hole to suit their size and also mudding round the lid. Some years they use many boxes. This year seventeen out of twenty looked at were occupied by Nuthatches. Many other birds, such as Robins and Wagtails, are occasional occupants, especially if the boxes are old and Tits have greatly enlarged the holes in former years. Similar boxes, but twenty inches square and with double span roof with projecting eaves, are provided with a hole, four by four-and-a-half inches. These larger boxes are firmly fixed on horizontal boughs against the trunk, not facing south-west unless very sheltered, and from twenty to thirty feet high. They are used by Owls, Jackdaws, Stock Doves, Kestrels, Squirrels, and occasionally by Stoats. Nearly all the Stock Doves' nests are destroyed early in the year by Jackdaws, etc., but they rear numerous broods in late summer and autumn. Barn Owls have young in some cases up to November. Jackdaws are dreadful nuisances, as they fill the boxes up with sticks. Where the boxes are placed in woods, however, the Jackdaws are not much trouble. Barn Owls don't care for deep woods. Kestrels are occasionally very numerous, and several pairs will breed in comparatively close proximity; I have seen as many as six fighting for one box at the end of March when they first arrive. In certain years scarcely a Kestrel will nest in a box, and very few in the trees. Among the numbers of boxes in my neighbourhood, spread over a comparatively large area, it is the greatest exception to find one unoccupied, although natural nesting sites abound everywhere.—E. G. B. MEADE-WALDO, Stonewall Park, Edenbridge, Kent.

The Levantine Shearwater (Puffinus yelkouanus) at Scarborough. (*The Naturalist*, November, 1900, p. 352.) Mr. R. Fortune, of Harrogate, records that a bird of this species, now in his possession, was shot at Scarborough on September 13th. The bird is an immature female, and has been submitted to Mr. Howard Saunders for identification. The Levantine Shearwater is the representative in the Mediterranean of our Manx Shearwater, to which it is very closely allied. It has once before been obtained in Yorkshire, and on four occasions in other parts of England.

Late Brood of Wild Pheasants. At the meeting of the British Ornithologists' Club held on October 17th, 1900, Mr. W. B. Tegetmeier exhibited a nestling Pheasant only a few days old. The bird had been sent to him from Mr. Alfred Dunnage, of Dedham, Colchester. It had formed one of a brood of nine or ten birds hatched out in a hedgerow, far from any covert.

An Observational Diary of the Habits of the Great Plover (Oedicnemus crepitans) during September and October. By Edmund Selous. (*Zoologist*, 1900, April, pp. 173-185, June, pp. 270-277, October, pp. 458-476.) The writer of this diary is at great pains to tell us precisely and minutely what happened at every moment in which he watched some Stone Curlews through September and October in East Anglia. We cannot help thinking it a mistake to print a note book. Mr. Selous could have given us a more valuable and practicable contribution by extending his observations of the Great Plover to other months and other localities, and then writing a summary, such as he gives at the end of these articles, enlarged and with a few quotations from his notebook. Among the conclusions arrived at concerning the habits of the Great Plover in September and October by Mr. Selous, we may mention that they have regular places of assembly during the day. As evening falls they indulge in excited motions which may be called dances, accompanied by their loud wailing notes. During the night they feed over the general surface of the country, returning to their places of assembly at very early dawn.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

THE BIRDS OF IRELAND. By Richard J. Ussher and Robert Warren. (Gurney and Jackson.) Illustrated. 30s. This is a book for which British ornithologists have waited long, and their patience is now amply rewarded by the production of a work of a thoroughness, accuracy, and completeness such as could only have been arrived at by many years of labour. Up to now Thompson has been the only author to treat of Irish ornithology in detail. His publication appeared fifty years ago, at a time when the Natural History of Ireland was sadly neglected. Of late years Irishmen have paid increasing attention to the fauna and flora of their country until the band of workers in this direction, although still small, is now one of which any country might be proud. Amongst these the authors of the present volume must by no means be counted least. They have attacked their subject in a thoroughly masterly way, and a book of exceptional excellence is the result. As the authors' object was to compile a local avifauna, they have wisely decided not to attempt to give a complete account of any species, nor to describe the birds themselves. The distribution of each species within the island is treated as the point of primary importance, and no pains have been spared in collecting, and, above all, in personally verifying, information for this purpose. The migrations of each species, as far as Ireland is concerned, is admirably dealt with, and in this the authors have received the valuable aid of Mr. R. M. Barrington, who has lately published a most exhaustive work on the subject. A list of Irish names, a well-arranged table, showing the distribution of the birds which have bred in Ireland in the nineteenth century, and some excellent maps, are further good features in the work. Owing to its geographical position, upon which depend its climate and the character of its land surface, Ireland offers a marked and interesting difference from England in its avifauna. Many birds common in England are either not found, or are very rare, there, a fact which is especially noticeable in many of our summer migrants which do not travel so far west, and in such birds as woodpeckers and the tawny owl, which require large old timber in which to breed. Thus Ireland is not so rich in species as Great Britain, but it is nevertheless rich in bird-life. Its extensive moors and lakes, its high cliffs and numerous estuaries are populated with a host of birds many of which are unfamiliar to most Englishmen, and its woods, although small and comparatively young, are the regular nesting haunts of such birds as siskins and cross-bills, which very rarely breed in England. Another fact of great interest is the increase of late years in Ireland, as breeding species, of such birds as the starling, woodcock, magpie, and mistle thrush. All these points receive special attention in the present volume, and are authoritatively dealt with. In sincerely congratulating the authors upon the universal excellence of their production, it is only fair to state that the greater part of the work is that of Mr. Ussher, and therefore to him is due the larger amount of praise, but in saying this we do not for a moment suggest that the portions of the volume for which Mr. Warren, who is an accomplished ornithologist, is responsible fall in any way short of the high standard attained in the rest of the work.

A TREATISE ON ZOOLOGY. Edited by E. Ray Lankester. Part II.—The Porifera and Cœlentera. By E. A. Minchin, C. H. Fowler, and G. C. Bourne, with an Introduction by the Editor. (A. and C. Black.) 15s. net. The second instalment of this great work, which in serial order precedes the part on the Echinoderma, issued last March, and already noticed in this journal, fully maintains the high standard of the latter. Like its predecessor, it is bristling with technicalities, and is not to be regarded as a book on popular natural history which can be taken up and read during any spare half-hour. It is essentially

a work for the serious and advanced zoological student; and from this point of view is everything that can be desired. Without for one moment underrating the excellent, systematic work of the three gentlemen whose names appear on the title-page, it must be acknowledged that the great feature of the present volume is the exhaustive essay by the editor on the "Cœlom." Those of our zoological readers who have reached middle age will recollect that in their college days they were taught that the pleuroperitoneal cavity of the higher animals was formed by the splitting of the mesoblastic layer of the embryo, so that the cavity in question was in no sense a morphological unit. Professor Lankester now demonstrates in the clearest manner how the cœlom (as the pleuroperitoneal cavity is now termed) is developed as a pair of buds from the primitive intestinal tract, and is originally a receptacle for the internal generative organs. It is therefore essentially a morphological factor of prime importance in the animal series, and one which justifies the separation of animals of higher grade than the sponges into two divisions, according as to whether the cœlom is or is not differentiated as a distinct cavity. Whether, however, the names "Enterocœla" and "Cœlomocœla" are the happiest that could have been selected for the groups in question is one on which a difference of opinion may be permissible. To follow the editor through his account of the history of the realisation of the true nature of the cœlom (an investigation in which he himself has played a leading part) would manifestly be impossible on the present occasion. But we may draw the reader's attention to the admirable description of the diminution of the size of this cavity in the Mollusca and Arthropoda, and the proportionately large development of the blood-vascular system at its expense. And mention should likewise be made of the remarkable investigations by Mr. Goodrich concerning a communication between the cœlomic and blood-vascular systems in the leech. Following on this epoch-making essay, which forms Chapter II. of the entire work, Mr. Minchin describes in an excellent manner the sponges; while in Chapters IV. and V. Mr. Herbert Fowler discusses those polyps which used to be called Hydrozoa, Mr. Bourne being responsible for the Sea-anemones, Corals, and Ctenophora, to which the two final chapters of the volume are devoted. A feature of the volume is the beauty and excellence of the illustrations, which have for the most part been prepared expressly for the work, and all of which are admirable examples of the manner in which minute structures should be figured. In only one case (Fig. 11, p. 20) have we noticed a discrepancy between the lettering of the figures and the accompanying description, and there it is but slight. Another feature is the presence of a separate index to each section of the work. To some readers, at any rate, the addition of a glossary would be a distinct advantage; but this is the only improvement we can suggest on what is in every way an admirably conceived and admirably executed undertaking.

A ROMANCER'S LOCAL COLOUR. By S. R. Crockett. (Newman and Guardia.) That innumerable host of very amateur photographers who affect to find pleasure in chasing, and, as they express it, "snap-shotting" men and objects, is rapidly becoming a nuisance to the more retiring and modest section of the community. A perusal of this light and humorous pamphlet may, perhaps, infuse some purpose into the methods of such photographers. It is scarcely necessary to add that, unlike the methods, cameras need not be changed—for, of course, the eminent novelist is, in his own words, "no special pleader" for the wares of Messrs. Newman and Guardia.

THE SCIENTIFIC FOUNDATIONS OF ANALYTICAL CHEMISTRY. 2nd Edition. By W. Ostwald, PH.D. (Macmillan.) 6s. net. Prof. Ostwald is well known as author of several valuable works on chemistry and chemical philosophy, and as a proof of his popularity among advanced students it is only necessary to mention that the first edition of the volume under notice has been translated into four languages. The book will commend itself to all who wish to know the why and the wherefore of the reactions which take place in the multifarious operations of the chemical laboratory. Our author says "a scientific foundation and system of analytical chemistry have hitherto failed us because the general knowledge and laws necessary for these have not been at the disposal of scientific chemistry itself. It is only within the last few years that it has become possible to elaborate a theory of analytical reactions." Prof. Ostwald is to be congratulated on the production of this book, which enables the student to work out his analyses, not by rule-of-thumb, but in an intellectual manner. The book does not pretend to be comprehensive, and, indeed, there is plenty of scope for amplification. The subject up to the present time has received scant attention at the hands of analytical chemists. Dr. M'Gowan has succeeded in supplying an able English translation.

A HANDBOOK OF PHOTOGRAPHY IN COLOURS. By Thomas Bolas, Alex. A. K. Tallent, and Edgar Senior. (Marion & Co.) Illustrated. 5s. It is interesting to note that the firm of Marion & Co. were the first to publish a work on trichromatic photography. At that time (thirty-one years ago) the process was in its extreme infancy, but now photography in colours may be said to be an accomplished fact. A perusal of the volume before us convinces us that an exhaustive treatise on this late development of the photographic art has at last been made available to the public. The work is divided into three sections, one of which is credited to each of the three authors respectively. In the first section a history of three-colour work, and a general survey of the many processes of colour photography, is presented, and it will be surprising to many to learn that the art of producing photographs in colours was carried out in a very crude fashion long before ordinary photography came into general use. In the next section, which is the largest in the book, instructions are given for carrying out experiments in colour photography. They were compiled from lecture notes made by Mr. Tallent for use in the Polytechnic classes, and will be valuable to those who wish to acquaint themselves with the practical details of the art. The remainder of the volume is occupied with a description of Lippman's Process of Interference Heliochromy. It was in 1891 that Lippmann, a French physicist, announced that he had been able to take direct photographs in the camera showing the spectrum in the true colours, and since that time rapid progress has been made.

"ASTRONOMICAL AND PHYSICAL RESEARCHES MADE AT MR. WILSON'S OBSERVATORY, DARAMONA, WESTMEATH." There is one type of observatory which seems almost peculiar to the British Isles. Private observatories there are in plenty in other countries, well-equipped, and more or less well-financed by wealthy men, and extremely well worked by able astronomers, but in the British Isles we find, over and over again, that the amateur astronomer of means not only equips the observatory and provides for the carrying on of the observations, but is also himself the worker, giving his brain, and, it may be, his all too scanty leisure to the furtherance of his science. The observations at Daramona have been carried out solely by Mr. Wilson and the occasional assistance of his personal friends, Dr. A. A. Rambaut, Prof. Fitzgerald, Prof. G. M. Minchin, and Mr. P. L. Gray. They are practical researches into the difficult problems of solar physics where *a priori* reasoning becomes worse than useless, since it is impossible to realise the actual conditions in a laboratory. The principal instruments used were a 24-inch silver-on-glass mirror of 10½ feet focus, a large polar heliostat having a plain silvered mirror of 15 inches diameter, a modification of Prof. Joly's meldometer, and a modification of Prof. Boys' radio-micrometer. Perhaps the most important and fundamental series of researches carried out were those on "the effective temperature of the sun." Here the general idea was to endeavour to *balance* the heat of the sun by means of an artificial source of heat at a high known temperature, and the method employed was purposely simple. Taking Angström's estimate of the loss in the earth's atmosphere, and the probable loss in the sun's atmosphere, as found in the paper by Mr. Wilson and Dr. Rambaut, on "The Absorption of Heat in the Solar Atmosphere," the effective temperature of the sun comes out as between 9000° C. and 10,000° C. In the paper by Mr. Wilson and Prof. Fitzgerald on "The Effect of Pressure on the Temperature of the Crater of an Electric Arc," a suggestion is made which bears, perhaps, on the cause of opacity in the solar atmosphere. The arc and the surrounding atmosphere were enclosed in a steel tube, closed at its end by a lens, and when the atmosphere was under great pressure, powerful convection currents were set up, and these currents scattered the light just as snow does, or any finely-divided transparent body immersed in another of a different refractive index. Light trying to get through is reflected backwards and forwards in every direction,

until most of it gets back by the way it came. In a similar manner, Mr. Wilson suggests, it may be that any part of the solar atmosphere which is at high pressure and where convection currents, or currents of different kinds of materials, are active, would reflect back to the sun any radiations coming from below, and reflect to us only the feeble radiation coming from interplanetary space. This may serve to explain the darkness of sunspots wholly or in part, but it also serves to emphasize our powerlessness to conceive the conditions existing below the sun's photosphere; our powerlessness to conceive why, in a gaseous body, practically isolated and cut off from disturbance by any other, there should be local heats and pressures, quite temporary in their character, to set up convection streams and currents. As an appendix to his most valuable work, Mr. Wilson has added a few specimens of the stellar and nebular photographs taken with his 2-foot reflector. That they are very beautiful it is almost superfluous to say. From the point of view of beauty, and perhaps, also, from the point of view of scientific value, we prefer the unenlarged photographs to the enlarged ones. As, for example, in the two photographs of the "dumb-bell" nebula in Vulpecula—one ten times the scale of the other—the larger copy loses completely the faint delicate nebulosity that fills up the space between the bounding intersecting circles, and thereby changes entirely the actual form and character of the nebula.

OLDEST BOOKS IN THE WORLD. By Isaac Myer, LL.B. Illustrated. (Kegan Paul.) 30s. net. The title page of this ponderous volume describes the contents as "An account of the religion, wisdom, philosophy, ethics, psychology, manners, proverbs, sayings, refinement, etc., of the ancient Egyptians: as set forth and inscribed upon some of the oldest existing monuments, papyri, and other records of that people, from the earliest historic times to A.D. 64; together with facsimiles and translations of some of the oldest books in the world. Also a study upon the origin, antiquity, and elevated ethics of the book written long before the Hebrew Exodus, now called the CXXVth chapter of the Book of the Dead, with an analysis of the same based on a comparison of numerous papyri copies; also a description of the Psychostasia, or trial of the conscience of the dead; with many illustrations of the same from the ancient monuments and papyri." The scope of the volume is thus sufficiently defined, and the main object seems to be to show, by extracts from archaic Egyptian writings, that the maxims and moral code of the ancient people of Egypt compare favourably with doctrines and ideas which have since been adopted. Thanks to the enlightened policy of the authorities of the British Museum, many people are now familiar with the chief facts of Egyptology and the chief compositions of the various dynasties. The "Book of the Dead" referred to above is a collection of chapters or separate compositions of different lengths found in Egypt inscribed upon pyramids, upon the walls of tombs, upon sarcophagi, and coffins, and amulets that were buried with the dead, and also found written upon long rolls of papyri which were placed in the tomb with the deceased. In the volume before us, fifteen writings are brought together, and different renderings are given of the original text. To students of religion, philosophy, ethics, and everyone else interested in the study of the thoughts and customs of men, the book is a desirable production, if only as an analysis of early beliefs and a reproduction of ancient writings.

WE have received from Mr. Murray the first two numbers of the "MONTHLY REVIEW" (2s. 6d.), and we are pleased to associate ourselves with the congratulatory chorus of our contemporaries in welcoming so handsome an addition to the monthly magazines. The turn-out of the book more than realises the promises of its prospectus, and fully maintains the high traditions of the Albemarle Street house; while its Editor may be congratulated on the varied and interesting character of its contents. So high a standard of literary excellence will certainly command a distinguished future.

THE advent of the "KNOWLEDGE" DIARY AND SCIENTIFIC HANDBOOK is announced in our advertisement columns. In view of the ever increasing interest taken in the study of Astronomy, the time has come when its votaries should possess an Annual specially devoted to their needs and requirements, and it is the intention of this new venture to meet that want.

BOOKS RECEIVED.

Publications of the Lick Observatory. Vol. IV. 1900.

Report of the Board of Education, 1899-1900.

A Year with Nature. By W. Percival Westell. (H. J. Drane: London.) Illustrated. 10s. 6d.

Problems of Evolution. By F. W. Headley. (Duckworth.) 8s. net.

The Child: A Study in the Evolution of Man. By Dr. A. F. Chamberlain. (Walter Scott.) 6s.

Bacteria. 2nd Edition. By George Newman, F.R.S. (Murray.)

Optical Tables and Data for Opticians. By Prof. S. P. Thompson. (Spon.) 6s. net.

Pitman's Shorthand Year-Book and Diary, 1901. 1s.

Mechanical World Pocket Diary, 1901. 6d.

Handbook for Literary and Debating Societies. (Hodder & Stoughton.) 1s. 6d.

A Hero of Romance. By Richard Marsh. (Ward, Lock & Co.) 6s.

Williams & Norgate's Book Circular, 1899-1900.

Studies: Scientific and Social. 2 Vols. By A. R. Wallace. Macmillan.) Illustrated. 18s.

Contents—Subject Index to General and Periodical Literature. By A. Cotgreave. (Elliot Stock.) 7s. 6d.

Photographic Optics. By Otto Lummer. Translated by Prof. S. P. Thompson. (Macmillan.) 6s. net.

Chemistry for Examinations. By H. W. Hill. (Allman.) 2s. 6d.

Songs and Lyrics. By Charles Whitworth Wynne. (Grant Richards.) 3s. 6d.

The Cape as I found it. By Beatrice M. Hicks. (Elliot Stock.) 5s.

A Brief History of Mathematics. By Dr. Karl Fink. Translated by W. W. Beman and D. E. Smith. (Kegan Paul.)

The Science of the Emotions. By Bhagaván Dás, M.A. (Theosophical Publishing Society.) 3s. 6d. net.

The Process Year-Book, 1900. (Penrose.)

Proceedings of the Society for Psychical Research. October, 1900. 6s.

Philips' London School Board Atlas. 1s. net.

Living Races of Mankind. Part III. (Hutchinson.) 7d. net.

Crowhurst's "Chess Board" Astigmatic Test Chart. By H. A. Crowhurst (of Sanders & Crowhurst, 71, Shaftesbury Avenue). 1s. 6d. Published by Newbold & Bulford, 46, Goswell Road.

The Scientific Roll. Bacteria. Vol. I., No. 1. Conducted by Alexander Ramsay. 1s. (R. L. Sharland, 38, Churchfield Road, Acton.)

THOMAS HENRY HUXLEY.*

A THOUSAND pages of biography sounds monstrous for an individual share in the story of mankind. But every now and then an actor passes across the stage of human society with so much quicksilver versatility, responsive to so many calls, exciting so much hostility and admiration, taking so large a part in the work, and the thinking, and the fighting, of his time, that every step in his career enchains the interest of a wide circle of readers. When humour and pathos, courage and sagacity, self-denying industry and domestic tenderness, gradually become conspicuous as characteristics of the man's sayings and doings, the long-drawn history of his pilgrimage assumes a dramatic fascination. He may still be, as sketched by rumour or by prejudice, the intellectual prize-fighter, the overbearing champion of revolutionary causes. Only, the harsh or rugged outlines of his temperament and activity are no longer repellent in the elaborated portrait. Premature distaste is bound to vanish before the presentment of a man bearing himself with uprightness, fortitude, and delicate sympathy in the everyday romance and the ordinary sufferings of mortal existence; still more, when it is found that his position of authority, at first extorted by a masterful intellect, is in the end conceded without grudging to a stedfast character; and, beyond all this, that his whole course was encompassed and comforted by what is hard

* "Life and Letters of Thomas Henry Huxley," by his son, Leonard Huxley. In two volumes. (London: Macmillan & Co., Limited.) 1900.

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for an eternally combative man to have, and impossible to be had by a mean man, the constancy and devotion of an incomparable band of friends.

The foregoing remarks are naturally suggested by the "Life and Letters of Thomas Henry Huxley," now given to the world by his son. The volumes might possibly have borne a little compression, a little rearrangement, a little more considerateness for living relatives of his dead antagonists. But the gaiety of nations will in no way be eclipsed by many of the outspoken judgments, and the cousins of Mr. X. or Mr. Y. may console themselves by observing that their kinsman is in the same boat with Lord Bacon. All these hundreds of pages are of a quality to be read with pleasure. They are of value for example of life and instruction of manners, including, like other books that have been so described, the *exemplum ad vitandum* along with things meet for imitation. There are many essential lessons involved, which haply some may learn to good effect, without knowing that they are being taught.

It cannot be expected that Huxley, followed through the pugnacity of a lifetime, will satisfy every taste or command assent to every opinion in the records of this narrative. That is a fortunate circumstance, perhaps foreseen and rejoiced in by his clever and filial biographer. He is not set before us as the Admirable Crichton of a novel, still less as merely "prig," "savant," or "Gelehrte," wittily assumed by the late Henry Sidgwick to be convertible terms. He is presented to us as a thoroughly human being, fighting at school, joking with middies on board the "Rattlesnake," fancying as a young man (sublimely innocent creature) that he was indifferent to money and fame, owning from first to last that he loved his friends and hated his enemies. Beyond a doubt the high lights of his portrait are relieved by occasional shadows. Of Tennyson he became a stalwart ally and admirer, but at twenty-seven, just after the Duke of Wellington's funeral, he writes to his betrothed, "I send Tennyson's ode by way of packing—it is not worth much more, the only decent passages to my mind being those I have marked." In his table-talk he quotes with evident approval a saying by Sir Henry Holland, "In my opinion Plato was an ass! But don't tell any one I said so!" The world would have suffered no substantial loss if this confidence had not been broken. Gladstone on Gadara he attacked with much controversial success, but he privately owns that his assault was designed to weaken Gladstone's political position. "As to Gladstone and his 'Impregnable Rock,' it wasn't worth attacking them for themselves, but it was most important at that moment to shake him in the minds of sensible men." That way of indirectly undermining an opponent may or may not be decent in the law-courts. It is scarcely a specimen of chivalrous, of Huxleyan, straightforwardness, but rather on a par with the controversial methods of a journalist who vindicates his own judgment on military tactics or the chemistry of the sun by showing that the other man is weak in spelling or faulty in syntax. Huxley was an eminent apostle of education for girls as well as boys, for women as well as men, for teachers as well as the taught, and yet we read (Vol. I., p. 212), of his preparing his "claws and beak" to keep women out of scientific societies, almost as if in 1860 he prophetically sympathized with the Austrian medical students of 1900. He had come to the impolite, may one be permitted to say the unworthy, conclusion, that five-sixths of womankind would never be anything but "intrigues" in politics, and "friponnes" in science. But perhaps in the end he found repentance (*see* Vol. I., p. 417). Wonderfully diversified as his knowledge was, it had its limits, or he could never have written to Kingsley that the Latin affirmation "*Cogito*" was preferable to the English "I think," "because the latter asserts the existence of an Ego—about which the bundle of phenomena at present addressing you knows nothing," though obviously the Ego is just as completely involved in the affix of *Cogito* as it is in the prefix of *I think*. He fancied that "Newton and Cuvier lowered themselves when the one accepted an idle knighthood, and the other became a baron of the empire," not considering that the pride of a cynic may sometimes be seen through the holes of his mantle, and that there may be as much vainglorioussness in refusing a title as in wearing one.

The story of what may be called the Battle of Oxford, in 1860, is here, as it was bound to be, told once more. It is told from the mouth of many witnesses. They are men of veracity and intelligence. They report words publicly spoken, and spoken under circumstances of exceptionally quickened attention, though no doubt also under circumstances of exceptional excitement. The extraordinary upshot is that no one can now be sure of what was really said either by Samuel Wilberforce or by Thomas Huxley. All evolutionists are agreed that Huxley won on that occasion a striking and valuable triumph. But it was almost certainly a triumph of his rhetoric, not his logic, of audacity, not of good taste. The Bishop of Oxford indulged in what he and his party probably deemed innocent and amusing banter. In return that eminent prelate, in the centre of his own diocese, before a throng of those who revered and loved him, was upbraided, according to one unrepudiated account, as a man "who prostituted the gifts of culture and eloquence to the service of prejudice and of falsehood." The absurdity of the thing is transparent when we ask ourselves how long at that date had the scientific world itself been converted to the doctrine of the transmutation of species, how much of it was still unconverted, and for how many years longer did leaders of science hold out against it in France, in Germany, in America, no less than in England. In the companion picture of 1894, again at Oxford, again before the British Association, and once more matched in a conflict of wits with a master of eloquence and sarcasm, Huxley stands forth, as some will think, a second time victorious. But now the triumph is won by refinement of taste, not by bitterness of retort. Put forward to second the vote of thanks for an address, in which the existing state of biological science had been treated with mockery, Huxley knew how to applaud what was laudable in the discourse without approving what was open to debate, and some will remember the dignity of tone and aspect, with which, alluding to his own share in the long Darwinian campaign, he uttered the words, "We of the Old Guard stand firm."

What these volumes tell us of Huxley's researches and his writings, of his innumerable lectures, of his work for societies, associations, congresses, institutions, royal commissions, and popular or unpopular causes, will make some readers wonder how a lifetime could contain it all. No doubt he crowded into his days more than his strength could bear, and had in consequence many penalties to pay, or, to use more strictly philosophical language, what followed, followed. None the less he lived the life of his choice. He won almost every sort of success that is open to such a career. He was always arguing, and always getting the better or the best of the argument. He called himself, it is true, an Agnostic, or Know-

nothing, and in that instance for a wonder he was foiled, for he never could persuade the world at large to believe in his total and absolute ignorance. In spite of the hard names by which he was fain to describe his attitude towards all theological dogma, we must remember that he was continually striving after light and truth. The kernel of his religion was this, that men are always working out their own salvation—or the other thing; that we are all hour by hour receiving the rewards and punishments of our own good and evil doings.

But the book itself must be read. It will take many behind the scenes of very unfamiliar playhouses, allowing them to be present at the birth and obsequies of the *x* Club, to take part in starting the Metaphysical Society, to follow the thread of many a scientific adventure, and, before they have done, they will have realized, if they did not know it already, that Huxley was not only a peculiarly distinguished man of science, but also a preacher of truth and righteousness, and not a preacher only.

WIRELESS TELEGRAPHY.—V.

By G. W. DE TUNZELMANN, B.SC.

PRACTICAL WORK.

WITH the exception of the unpublished experiments of Professor Hughes referred to in my last article, nothing seems to have been done in the way of utilising Hertzian electric waves for the purposes of telegraphic communication before the year 1895.

In April of that year, Professor A. Popoff, of the Cronstadt Torpedo School, described to the Russian Physical Society the apparatus shown in Fig. 1, which he employed as a receiver for Hertzian waves. It consisted of a tube coherer built in two sections, and having one of its terminals connected with a vertical wire, and the other with the earth. When a wave fell upon the coherer, causing its resistance to fall from an almost infinite value down to a few hundreds of ohms, a current from the battery was enabled to flow through the circuit and energise the electro-magnet of an ordinary Siemens telegraph relay, thereby closing a circuit, not shown in the illustration, containing a large battery and a telegraphic recorder, which continued in action as long as the current flowed through the battery in the coherer circuit. As soon, however, as coherence was set up, the electro-magnet of the electric bell was energised simultaneously with that of the relay, and the bell-hammer striking upon the central plate of the coherer caused decoherence, so that, unless the waves continued and re-established the state of cohesion, the recorder was thrown out of action.

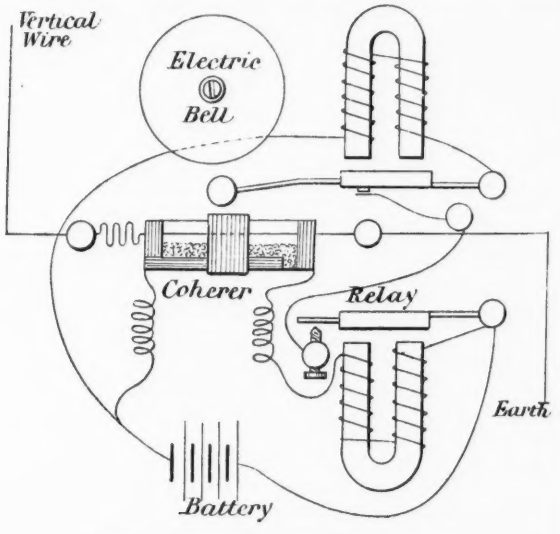

FIG. 1.—Popoff's Hertzian Wave Receiver.

Using a Hertz oscillator with 30 centimetre spheres, Popoff was able to send signals over a distance of a kilometre, which he extended to five kilometres, by replacing the Hertz oscillator by a Bjerknes one with spheres 90 centimetres in diameter.

Very shortly afterwards Captain Jackson made some experiments for the Admiralty at Devonport, and succeeded in sending messages from one ship to another. His apparatus, however, and the results obtained with it, were treated as confidential and have not been published.

In June, 1896, Guglielmo Marconi, a young Italian, and a pupil of Professor Righi, applied for provisional protection for "Improvements in transmitting Electrical Impulses and Signals and in Apparatus therefor," and filed a complete specification on the 2nd of March, 1897. At the time of making his provisional application Marconi's apparatus was in a somewhat crude form, but it contained important improvements in details, and in July, 1896, he had the fortune of obtaining the assistance and support of the Postal-Telegraph Department, through the good offices of Sir W. H. Preece, who was then the Chief Engineer of the Post Office.

With this powerful co-operation, combined with his own indefatigable industry and experimental skill, Signor Marconi succeeded in overcoming a host of difficulties, and in developing a commercially practical system of telegraphy based on Hertzian electric waves.

The transmitting apparatus employed for long distances when it is not required to concentrate the waves in a definite direction is shown in Fig. 2.

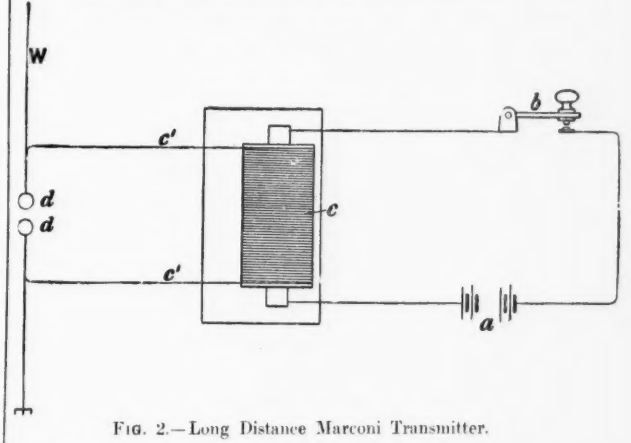

FIG. 2.—Long Distance Marconi Transmitter.

The small spheres, d, d, are connected by the wires, c', c', with the secondary terminals of an induction coil, c, and one of them is also connected with the vertical wire, W, while the other is earth-connected. When the Morse key, b, is depressed, the coil is energised by the battery, a, and therefore, as long as it is kept down, a stream of sparks is maintained between the spheres, d, d.

When it is desired to send a beam of rays in some

definite direction, the transmitter used by Marconi is one devised by Professor Righi, of Bologna, and shown in Fig. 3. The two large spheres, e, e, are 11 centimetres

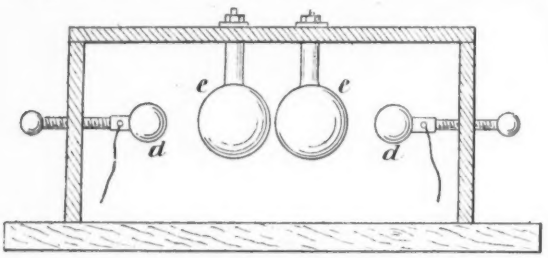

Fig. 3.—Righi Oscillator for use with Reflector.

in diameter, and are separated by a space of a millimetre. In order to concentrate the beam of rays in the required direction the oscillator is placed in the focal line of a parabolic cylindrical reflector, as shown in Fig. 4.

The most important part of the receiver is the coherer, which consists of a small glass tube (Fig. 5), about two and a half millimetres in internal diameter and some four centimetres in length. Two silver pole pieces are lightly fitted into this tube, separated by a gap of about a millimetre, containing a mixture of 96

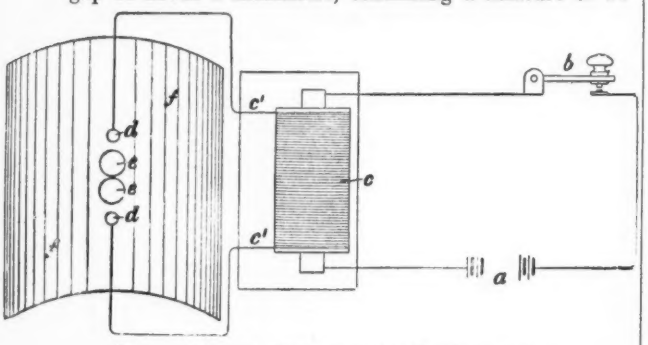

Fig. 4.—Marconi Transmitter with Parabolic Reflector.

parts of nickel and 4 parts of silver, not too finely granulated, and worked up with the merest trace of mercury. This powder must not be packed too tight, or the action will be irregular and over-sensitive to slight outside disturbances, while if too loose it will not be sufficiently sensitive. It

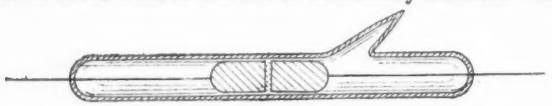

Fig. 5.—Marconi Coherer.

is found that the best adjustment is obtained when the coherer works well under the actions of the sparks from a small electric trembler placed at a distance of about a metre. The tube is then exhausted on a mercury pump until the pressure falls to about a millimetre, when the tubulure left for exhausting it is sealed off. The tubes are tested over a distance of 18 miles before being put into use, and when all the requisite precautions are observed, Signor Marconi finds them as reliable as any other telegraphic instruments, and not liable to get out of order when in use. His experience in this is confirmed by that of Professor Fleming. If the tubes are not exhausted they are found to grow gradually less sensitive, probably from slight oxidation going on, and this of course would not be permissible in commercial instruments.

The general arrangement of the receiving apparatus for long distance work without a reflector is shown in Fig. 6. j, j^3, is the coherer tube, with its silver pole

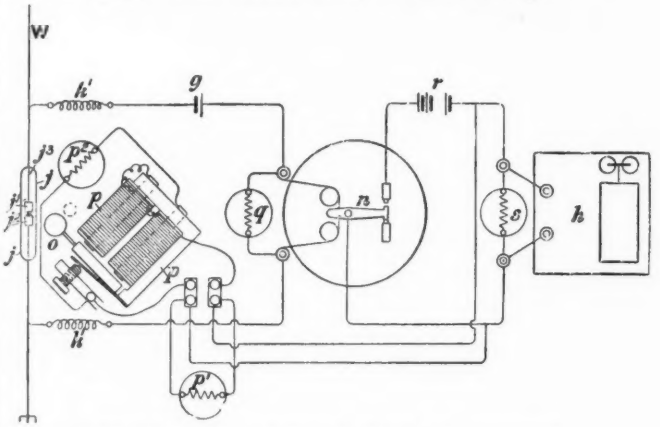

Fig. 6.—Marconi Receiver with Vertical Wire and Earth Connection.

pieces, j^1, j^2. The coherer forms part of a circuit containing a local cell, g, and a sensitive telegraph relay. When electric waves impinge upon the coherer its resistance falls from a nearly infinite value to something between 500 and 100 ohms, which allows the cell, g, to energise the electro-magnet of the relay, n, and close a circuit containing a larger battery, r, together with a Morse recorder, h, and a trembling electric bell, p, to act as decoherer. The hammer, o, of the bell is so adjusted as to tap the coherer tube and shake the filings in it. If at the moment in which these actions took place the electric waves in the resonator had died away, this tap would restore the coherer to its normal condition of practically infinite resistance, and a dot only would be recorded on the tape of the Morse machine. If, however, the key of the transmitter were kept depressed, then waves would succeed each other at very short intervals, so that the acquired conductivity of the coherer would only be momentarily destroyed by the tap of the bell-hammer, and immediately re-established by the electric waves. Now the armature of the Morse recorder is somewhat heavy, and therefore has considerable inertia, so that it cannot follow the very rapid vibrations of the tongue of the relay. The practical result, therefore, is that the Morse instrument gives an exact reproduction of the dots and dashes produced by the movements of the key at the transmitting station, although during each movement of the key, however short, the armatures of the relay and of the tapper go through a series of rapid vibrations dependent on each other.

Small choking coils, k^1, k^1—that is to say, coils wound so as to have self-induction or electric inertia—are introduced between the coherer and the relay, their effect being to compel the greater part of the oscillatory current induced in the circuit by the electric waves to traverse the coherer, instead of wasting the greater portion of its energy in the alternative path afforded by the relay. If these coils are omitted, other circumstances remaining the same, Signor Marconi finds that the dis-

tance at which the signals can be distinguished is reduced to nearly half that attained when they are employed.

In order to screen the receiver from the violent surgings which would be set up when using the transmitters at the same station, he enclosed the whole of the receiving apparatus, with the exception of the recorder, in a metallic box. As some of the waves picked up by the recorder would, by travelling along the leads into the receiver, injure the coherer, he chokes off all such effects by interposing suitable choking coils between the recorder connections and the terminals of the receiver. These choking coils consist of a few turns of insulated wire wound in layers, each layer being separated from the adjacent ones by means of sheets of tinfoil in metallic connection with the enclosing box. This earthed tinfoil prevents the waves from passing inductively from one turn of the choking coil to the next. The earthed terminal of the receiver is connected to the box and need never be touched. Signor Marconi also found that, unless provision was made against it, the relay, the tapper, and the recorder all produced disturbing effects on the receiver, but he got rid of these effects by introducing suitable non-inductive resistances, q, p^2, and s, in parallel with them, or, as telegraphists say, he shunted them with these resistances. This prevented all sparking at the contacts, and sudden perturbations, or jerks, due to the local battery current, all of which would otherwise produce disturbing effects on the coherer.

When it is desired that the receiver should only pick up waves coming in a certain definite direction, the arrangement shown in Fig. 7 is employed. This differs

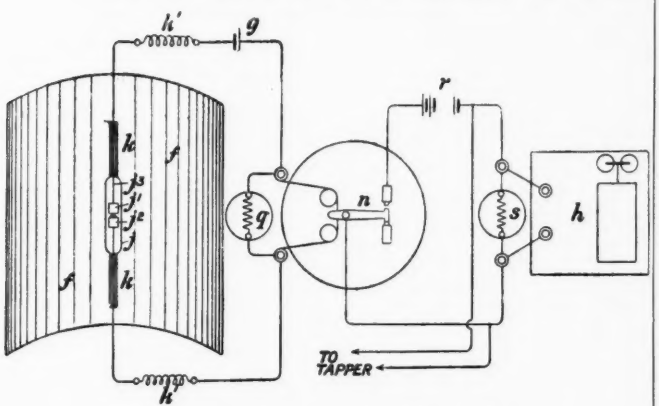

FIG. 7.—Marconi Receiver with Parabolic Reflector.

from that shown in Fig. 6 only in the vertical wire and earth connection being done away with, and replaced by the two copper strips, k, k, the sizes of which must be carefully adjusted so that the receiver may be in syntony with the transmitted waves; and in a parabolic cylindrical reflector being placed so that the coherer tube lies with its axis in its focal line.

My readers will observe the considerable similarity between Marconi's apparatus and that of Popoff; although I believe that, when Signor Marconi designed his apparatus, Popoff's results were unknown to him. Both used the coherer to actuate a relay, and thereby bring into action a telegraph recorder, and both used a tapper to cause decoherence. Popoff also anticipated Marconi in the use of a vertical wire and earth connection on his receiving instrument, but does not seem to have recognised its necessity on the transmitter.

The use of the tall vertical wire on both transmitter and receiver forms one of the most notable of Marconi's improvements, and the one which has perhaps played the largest part in his successful transmission of signals over long distances. A horizontal wire is no use, even if added at the top of a long vertical wire, so as to keep it at a great distance from the earth. The effect of the long wire is to increase the length of the waves generated in the ether, and, therefore, as was pointed out in my first article, to augment their power of penetrating obstacles, the wave length being about four times the length of the wire. The reason that it acts so much better in a vertical position than in any other is that that position is the one which is least favourable to the production of induced oscillating currents in the earth, which, if set up, must dissipate uselessly the amount of energy required to excite them.

Signor Marconi finds that a conductor with considerable capacity, such as a sheet of wire net, attached to the top of the vertical wire by means of an insulating rod, is to some extent equivalent to increasing the length of the wire. He found experimentally that, if the wires at the two stations are equal in height, the distance to which signals could be transmitted was approximately proportional to the square of that height, the actual maximum distance being somewhat in excess of that calculated from this assumption. Professor Ascoli has confirmed this result mathematically.

One of the Marconi masts, 150 feet high, which was erected at the South Foreland last year, is shown in Fig. 8. This mast is now of historic interest, as being the one which was used for the first transmission of messages by the new system of telegraphy between England and France, the French station being at the village of Wimereux, near Boulogne, and at a distance of 32 miles from the South Foreland. In place of using a high mast the vertical wire might, where the opportunity exists, be suspended from the top of a cliff or of a lofty building, and Mr. Marconi has in this way successfully transmitted messages between Bournemouth and Alum Bay in the Isle of Wight, a distance of about 14 miles. No mast was employed at the latter station, the vertical wire being allowed to hang over the edge of the cliff, the instrument and earth connections being at the top, while the lower end of the wire, which was about 100 feet long, hung free in space, the wire being kept at a distance of about 30 feet from the face of the cliff.

I am not aware that any attempts have been made to employ the Marconi apparatus with reflectors for greater distances than two miles. Hertz found that to obtain good results with reflectors they must be large compared with the wave length, and the distance of the mirror from the oscillator must not be less than a quarter of the wave length, as clearly follows from what I explained in my first article, that the emission point of the waves is a quarter of a wave length from the vibrating source.

It will be seen, therefore, that it would hardly be practicable to employ reflectors in conjunction with high masts for transmitting beams of rays in a given direction. For example, with the vertical wire 150 feet long, such as that in use at the South Foreland, the wave length would be about 600 feet. The dimensions of the mirror would therefore have to be large compared with this, and placed at a distance not less than 150 feet from the oscillator.

The use of reflectors is, however, of considerable value

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for communicating between ships, or ships and the shore, at short distances.

By the use of reflectors it is possible to project the electric waves in an almost parallel beam, which will have no effect upon any receiver not lying in its course, whether this receiver be syntonic with the waves or not. This, as Signor Marconi has pointed out, would enable

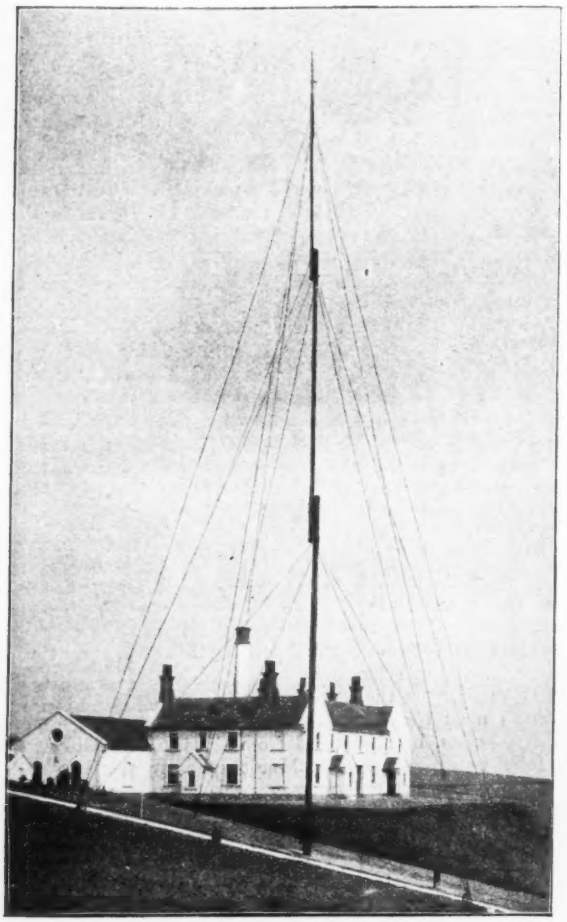

FIG. 8.– Marconi Mast at the South Foreland.

several forts, hill-tops, or islands to communicate with each other in war time, without any fear of the enemy tapping or interfering with the signals, for, if the forts were on a small height, the beams could easily be directed so as to pass over any position that might possibly be occupied by the enemy.

In some experiments, made over a distance of one and three-quarter miles, Signor Marconi observed that quite a small movement of the reflector of the transmitting instrument was sufficient to stop the reception of the signals by the receiver. The zone, within which the receiver had to be placed for a given position of the transmitting reflector, not being more than about 100 feet in breadth.

"There exists," says Signor Marconi, in his paper read in March, 1899, before the Institution of Electrical Engineers, "a most important case to which the reflector system is applicable, namely, to enable ships to be warned by lighthouses, light-vessels or other ships, not only of their proximity to danger, but also of the direction from which the warning comes. If we imagine that A is a lighthouse, provided with a transmitter of electric waves, constantly giving a series of intermittent impulses or flashes, and B a ship provided with a receiving apparatus placed in the focal line of a reflector, it is plain that, when the receiver is within range of the oscillator, the bell will be rung only when the reflector is directed towards the transmitter, and will not ring when the reflector is not directed towards it. If the reflector is caused to revolve by clockwork, or by hand, it will therefore give warning only when occupying a certain section of the circle in which it revolves. It is therefore easy for a ship in a fog to make out the exact direction of the point A, whereby, by the conventional number of taps or rings, she will be able to discern either a dangerous point to be avoided or the port or harbour for which she is endeavouring to steer."

Marconi's apparatus was installed last month on board "The Princess Clementine," one of the Belgian boats carrying on the passenger service between Dover and Ostend. It is stated that the distances covered exceeded eighty miles, and that the apparatus is shortly to be supplied to other vessels belonging to the Belgian Company.

There is a difficulty which will have to be overcome if the system is to come into extensive use, and that is the interference of simultaneous messages coming from different stations, all of which would affect all receivers within range, with the result of making the messages unintelligible.

Professor Lodge has devised and patented some interesting forms of syntonic transmitters, but, as far as I am aware, he has not yet succeeded in transmitting syntonic messages over any considerable distances. A syntonic radiator is necessarily one which produces persistent oscillations instead of having them damped out almost immediately. Now this damping out means that the ether rapidly takes up the vibrations, so that making a radiator syntonic means making it feebler.

It is stated that Signor Marconi has now succeeded in devising apparatus by which syntonic messages have been successfully transmitted to distances of over 30 miles, but as the patents are not yet completed I am not able to obtain any information as to the methods employed.

If he can do this it will prevent the interference above referred to, as the receiver at any station will respond only to the messages intended for it.

Figures 2, 4, 6, 7, and 8 are reproduced by kind permission from Signor Marconi's paper in the "Journal of the Institute of Electrical Engineers,' Vol. 28, 1899.

ERRATUM.—Article IV., KNOWLEDGE, October, 1900, p. 235 column 2, line 7, for "10·7 centimetres," read "10^{-7} cm."

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

A convenient means for testing the optical qualities of objectives is very desirable. It is essential that the objects used for this purpose should be most carefully prepared and properly mounted. For low powers the proboscis of the blow-fly is usually recommended; also the scales of butterflies. These objects should appear distinct in detail, flat, and free from marginal colouring. For medium powers stained micrococci, bacteria, and starch grains are useful. For high powers, especially immersion objectives, various diatoms are used, such as *Navicula lyra*, *Pleurosigma angulatum* and *Amphipleura pellucida*.

Those who do not possess a turntable will find a slide centerer an excellent substitute. This piece of apparatus may be readily prepared as follows:—Rule a rectangle the size of an ordinary

glass slip on a piece of stout cardboard, draw diagonal lines to locate the centre, and then draw a series of squares and circles about this centre equal to the diameters of the cover-glass most used. This will be found quite as satisfactory as the turn-table for mounting purposes.

Japanese tissue paper used by dentists is excellent for wiping and cleaning lenses, oculars, and objectives.

To examine in the living state small freshwater algæ, protozoa, small crustaceans, hydra, small worms, and other minute plants and animals, they must be mounted in some inert liquid, as water; preferably a drop of the liquid in which the organisms live and grow. Their motion may be reduced by mounting in a solution (10 per cent.) of gum arabic.

Minute objects like diatoms and the scales of insects may be arranged in geometrical figures or in some fanciful way, either for ornament or more satisfactory study. To do this the cover-glass is placed over a guide. The guide for geometrical figures may be a net-micrometer, or a series of concentric circles. In order that the objects may remain in place, however, they must be fastened to the cover-glass. As an adhesive substance, liquid gelatine thinned with an equal volume of 50 per cent. acetic acid answers well. A very thin coating of this is spread on the cover, with a needle or in some other way, and allowed to dry. The objects are then placed on the gelatinized side of the cover and carefully got into position with a mechanical finger made by fastening a cat's whisker to a penholder. After the objects are arranged the operator breathes very gently on the cover-glass to soften the gelatine. On drying the objects will be firmly anchored. In mounting, one may use Canada balsam, or mount in a dry cell.

Shellac cement is a very useful medium for sealing preparations and for making shellac cells. It may be readily prepared by half filling a bottle with scale or bleached shellac, and adding thereto sufficient of 95 per cent. alcohol to fill the bottle. The whole should be shaken occasionally, and allowed to stand until a clear stratum of liquid appears on the top. This supernatant liquid is then filtered through absorbent cotton into an open dish or wide-mouthed bottle. To every 50 c.c. of this filtered shellac, 5 c.c. of castor oil and 5 c.c. of Venetian turpentine are added to render the shellac less brittle. The filtered shellac will be too thin, and must be allowed to evaporate till it is of the consistency of thin syrup. It is then put into a capped bottle and is ready for use.

The examination of living micro-organisms is, as a rule, best carried out by means of the "hanging drop." For this purpose a thick glass slide having a concave well in the middle is made use of. The "hanging drop" is made in the following manner: Place a small drop of water on a clean cover-glass on the table. The drop must be small enough so that it will not run if the cover-glass is placed on edge. The organisms are then placed in the water and a ring of vaseline is placed around the edge of the well on the upper side of the concave slide, by means of a brush or match stick. The slide, with its ring of vaseline, is then inverted over the cover-glass and gently pressed down. The cover-glass now adheres to the slide, which is then inverted. Care should be taken to see that the ring of vaseline is continuous around the edge of the well. If such is the case no evaporation of the drop of water can take place, and hence the hanging drop can be examined at leisure and without the presence of annoying currents in the liquid.

A great variety of bacteria, moulds and yeasts can be obtained by the student of bacteriology from the air. The following simple procedure, suggested by Dr. F. Nory, will enable anyone to grow these bacteria from the air, and thus obtain a variety of organisms suitable for examination in the living condition and for staining purposes. Place two or three sound potatoes and a knife in a vessel of water and boil for twenty minutes. Pour away the water, and, when cool, cut them in halves with the sterilized knife, taking care to touch neither the blade nor the potatoes with anything. Transfer the potatoes, cut side uppermost, to a piece of paper, and leave them exposed for from ten to thirty minutes. Then cover them with a glass tumbler, and at the end of about forty-eight hours they will begin to show one or more pinhead growths. These growths are due to organisms, which, floating about in the air, have dropped on the potatoes and have there found a soil congenial to their growth.

The germination of seeds in sterilized water to which varying quantities of oxygen had been added has been studied by M. P. Maze. He concludes that, while life appears to remain latent, certain slow changes take place, although germination under water may fail on account of lack of aeration. Some small seeds are developed slowly by the atmosphere within their coats. Starchy seeds under water quickly lose all power of germinating, oily seeds retain it longer; but there is no proof that any seeds can long retain their vitality. The weakening of the submerged embryos is attributed to the accumulation of poisonous products, especially aldehyde.

Messrs. R. and J. Beck have placed on the market a new microscope on the "Continental" model which they call the "London." Many improvements have been introduced in matters of detail which make it worthy of notice. The workmanship is in Messrs. Beck's best style, and the price reasonable for a first-class instrument.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

BRORSEN'S COMET.—The return of this interesting short-period comet is expected early in 1901, and a sweeping ephemeris has been published in *Ast. Nach.*, 3670, by A. Berberich, of Berlin. From this it appears that the comet is now invisible in English skies owing to its southern declination, but that it is travelling northwards and ought to be favourably presented to view at the end of January and in February, 1901. Berberich's ephemeris is for Berlin midnight, and the positions at eight day intervals are:—

Date.	R.A. H.	R.A. M.	Dec. °	Dec. ′	Distance of Comet in Millions of Miles.
1900. December 17 ...	22	8	−44	32	62
,, 25 ...	21	59	−39	46	56
1901. January 2 ...	21	39	−33	4	47
,, 10 ...	21	9	−22	54	40
,, 18 ...	20	8	− 9	37	38

The path is from Grus through Piscis Australis and Capricornus, after which it passes through Aquila. It will be nearest to the earth at the middle of January, but at that time will be too near the sun for observation. Soon afterwards the comet ought to become visible just before sunrise low in due east. This comet was discovered in 1846, and it has a period of revolution of about 5½ years. It was last seen in 1879, and should have returned in 1884, 1890, and 1895, but escaped detection. It is now questionable whether the comet exists in the same form and dimensions as in 1879 and previous years. The supposition is that, like Biela's double comet, it is practically lost to us as an observable object But it remains to be seen whether the large telescopes of the present day are capable of redetecting the comet, for they will sure to be employed in the search during the months of January and February next.

COMET BORRELLY-BROOKS.—This object is now exceedingly faint, but its position is very favourable. It was observed by Dr. Schorr at Hamburg on October 16th, and may possibly be picked up in December in a good instrument. The following places are by Wedemeyer (*Ast Nach.*, 3670):—

Ephemeris for Berlin Midnight.

Date. 1900.	R.A. H.	R.A. M.	R.A. S.	Dec. °	Dec. ′	Dec. ″	Distance in Millions of Miles.
December 10 ...	16	19	17 ...	+ 71	52	56 ...	175
,, 14 ...	16	26	54 ...	+ 73	0	30 ...	181
,, 18 ...	16	34	55 ..	+ 74	12	34 ...	184
,, 22 ...	16	43	25 ...	+ 75	28	45 ...	187
,, 26 ...	16	52	33 ...	+ 76	48	38 ...	190
1901. January 6 ...	17	23	15 ...	+ 80	43	6 ...	198

The comet is thus moving slowly to N.N.E. amongst the stars in Ursa Minor.

BARNARD'S COMET (1884 II.).—This object escaped observation at its last two returns, and there seems a very meagre prospect of it being seen at the present time owing to generally unfavourable conditions. Its computed position on December 2nd is R.A. 20h. 14m., Dec. −22° 5′.

FIREBALL OF SUNDAY, OCTOBER 21, 8H. 35M.—A magnificent slow-moving fireball was observed from all parts of England. The sky was clear over the country, and as the meteor travelled leisurely along its course from S.W. to N.E. there occurred three explosions or outbursts, and these induced very vivid lightning-like flashes. At Tewkesbury the meteor is said to have given a momentary flood of brilliant moonlight, and about three minutes later there was a detonation like that produced by the firing of a heavy gun at a great distance.

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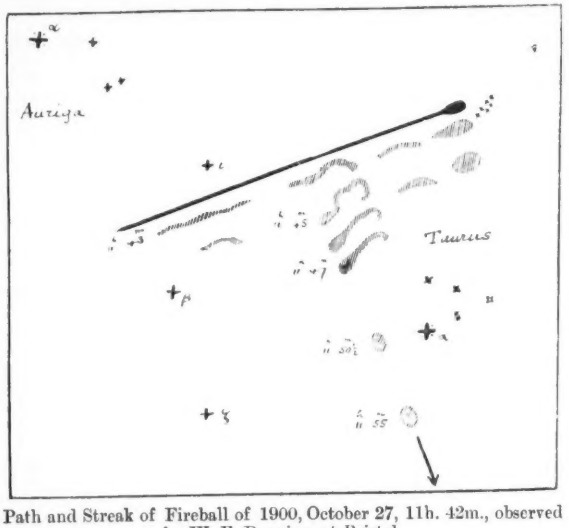
Mr. Ballard, of Leigh Linton, near Malvern, says that the meteor fell within ten yards of his house. It appeared just over him, and he moved to be out of its way when it fell just over the hedge. The Rev. H. J. Scott, writing from Clun, Shropshire, says that three minutes after the meteor had disappeared he heard a sound like the distinct but distant roll of artillery for 15 or 20 seconds. Another observer at Clun says the meteor passed overhead and that two minutes later he heard a rumbling sound resembling distinct thunder. As the nucleus sailed along several vari-coloured fragments detached themselves from it. At Devizes some observers counted seven of these smaller bodies, and say that the phenomenon ended in a shower of sparks followed by the sound of a gun. A considerable number of descriptions have appeared in the newspapers, but they are very incomplete and in some instances inaccurate. Hence it is extremely difficult to deduce a satisfactory real path, but it certainly appears that the object was very low in the air. From some of the most reliable accounts it would seem that the radiant was in Sagitta at 300° + 22°, and that the meteor passed from a height of 68 miles over a point near New Radnor to a height of 20 miles over Shiffnal. Length of path 66 miles, and velocity 11 miles per second. The fireball was certainly a splendid object, but it is questionable whether it justified the *Daily Mail's* expression that it was "one of the brightest meteors seen in an English sky for many a year!" About 10 minutes after the fireball had appeared, another and a smaller one was seen moving in a contrary direction, and at 9h. 25m. a third appeared. There was also a bright meteor at about 10h., and at 11h. 58m. Prof. A. S. Herschel recorded one equal to Venus falling slowly from 149° + 46° to 155° + 38° and leaving a train of orange sparks. The latter was also seen by Mr. C. L. Brook, at Meltham, near Huddersfield. The radiant was at 350° − 4°, and height of the object 63 to 48 miles over the North Sea.

OBSERVATIONS OF SHOOTING STARS IN OCTOBER.—The month was tolerably favourable, and at Bristol 141 meteors were observed in 12¾ hours' watching. The radiants well determined were as follows:—

Date.	Radiant. °	°	No. of Meteors.	Appearance.
October 23—27 ...	99	+ 13	10	Rapid streaks.
,, 23 ...	92	+ 15	5	Rapid streaks. Orionids.
,, 26—27 ...	91	+ 16	5	,, ,, ,,
,, 23—27 ...	43	+ 12	8	Rapid. White.
,, 23—27 ...	45	+ 27	8	,, ,,
,, 23—27 ...	57	+ 9	6	Rather swift.
,, 23—27 ...	47	+ 43	6	Slowish.
,, 26—27 ...	123	+ 42	4	Rapid streaks.

FIREBALL OF OCTOBER 27, 11H. 42M.—The writer at Bristol saw a meteor several times brighter than Venus, shooting rapidly from 79° + 33° to 56° + 24½°. It left a bright irregular streak, a section of which was watched with a small opera-glass, power 2, for 13 minutes. During this period it drifted 17 degrees in a southerly direction. Soon after its first projection it formed a perfect sickle, the denser and more enduring section forming the handle. The meteor was observed by Mrs. W. H. S. Monck, of Dublin, passing just below the belt of Orion in a direction from east to west. The meteor had a radiant at 136° + 34°, and its height was from 76 miles over a point 5 miles W. of Basingstoke to 67 miles over a point 8 miles S. of Salisbury. Observed path 34 miles, and velocity about 40 miles per second, the duration of flight being estimated 0·9 second.



Path and Streak of Fireball of 1900, October 27, 11h. 42m., observed by W. F. Denning, at Bristol.

THE LEONIDS OF 1900.—At Bristol the weather was unfavourable on November 13th and 14th, but occasional observations showed that Leonids were very scarce. There were a few brilliant slow-moving Taurids from a radiant at 58° + 10°.

THE FACE OF THE SKY FOR DECEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.45 and sets at 3.54; on the 31st he rises at 8.8 and sets at 3.58. He enters Capricornus, and Winter commences on the 22nd at 7 A.M. Few sunspots are to be expected.

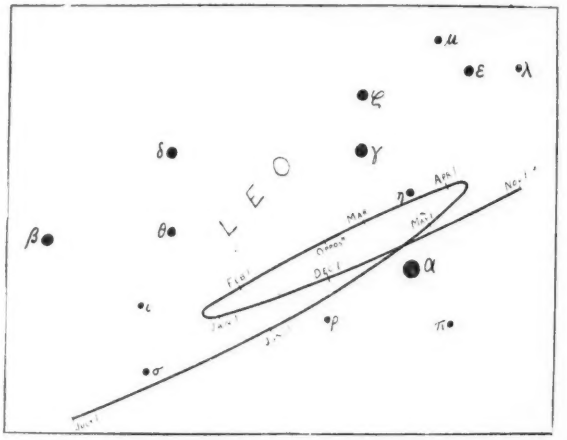
THE MOON.—The moon will be full on the 6th at 10.38 A.M., will enter last quarter on the 13th at 10.42 P.M., will be new on the 22nd at 0.1 A.M., and will enter first quarter on the 29th at 1.48 A.M. The more interesting occultations during the month are as follows:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Dec. 3	19 Arietis	6·2	5.7 P.M.	31	70	5.55	287	323	11 11
,, 5	ω^2 Tauri	4·6	6.11 P.M.	26	67	6.46	312	353	13 11
,, 10	κ Cancri	5·0	8.56 P.M.	111	148	9.52	278	317	18 14
,, 26	51 Aquarii	5·8	7.42 P.M.	29	356	8.33	280	244	4 20

THE PLANETS.—Mercury is a morning star, reaching the greatest westerly elongation of 20° 50′ on the 8th. On the 3rd he rises at 5.50 A.M., and on the 10th at 5.58 A.M., so that his position may be considered fairly favourable, especially as there are no bright stars or planets in the neighbourhood.

Venus is a morning star, rising shortly after 4 A.M. on the 1st, and at about quarter to 6 on the 31st. On the 15th the illuminated portion of the disc is 0·836, and the apparent diameter 12·8″.

Mars is visible before midnight throughout the month, rising on the 1st at 10.35 P.M., and on the 31st at 9 21 P.M. The path of the planet is easterly through Leo (see diagram). On the 15th, the illuminated part of the disc is 0·907, the apparent diameter 8·6″, and the distance from the earth about 100 millions of miles.



The apparent Path of Mars, from November 1, 1900, to July 1, 1901.

Eros, which is now receiving so much attention in a

new determination of the solar parallax, may be observed throughout the night. The following is an abridged ephemeris, for Berlin midnight :—

	Right Ascension.			Declination.	
	H.	M.	S.	°	′
December 1 ...	1	27	20	+50	23·8
„ 6 ...	1	26	39	48	40·0
„ 11 ...	1	28	44	46	45·7
„ 16 ...	1	33	26	44	44·3
„ 21 ...	1	40	36	42	38·3
„ 26 ...	1	50	1	40	30·0
„ 31 ...	2	1	23	38	21·0

The planet is nearest to the earth on December 26th, when its distance is 0.3148 that of the Sun, and its parallax estimated at about 28″. The planet may be distinguished from neighbouring stars by its relative motion, which is very rapid; its apparent stellar magnitude will be about 9.0.

Jupiter, Saturn and Uranus are too near the Sun to be observed, being in conjunction on the 14th, 29th, and 5th respectively.

Neptune is in opposition on the 20th, and may be observed throughout the night. During the month he describes a short westerly path in the most eastern part of Taurus, but as it lies in the Milky Way, careful observation will be required to identify the planet. The path is a little to the south of a line joining η Geminorum and 132 Tauri, at nearly equal distances from the two stars.

THE STARS.—About 9 P.M. at the middle of the month, Cancer, Gemini, and Canis Minor will be towards the east; Auriga high up towards the east; Taurus and Orion towards the south-east; Perseus and Cassiopeia nearly overhead; Aries and the head of Cetus in the south; Andromeda high up towards the north-west; Pegasus a little south of west; Cygnus and Lyra in the north-west; and Ursa Major a little east of north.

Minima of Algol at convenient hours occur on the 14th at 9.25 P.M., and on the 17th at 6.14 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of November Problems.

(P. G. L. F.)

No. 1.

1. R to KR3, and mates next move.

No. 2.

Key move—1. Q to Rsq.

If 1. . . . P to K5, 2. Q to KR8ch.
1. . . . B×P, 2. K×B.
1. . . . Any other, 2. Q×Bch.

CORRECT SOLUTIONS of both problems received from Alpha, W. de P. Crousaz, G. A. Forde (Capt.), H. S. Brandreth, Major Nangle, and one unsigned from Bradford.

Of No. 1 only from W. F. Preedy, H. Le Jeune.

H. Le Jeune.—QKsq would be met by . . . PK5.

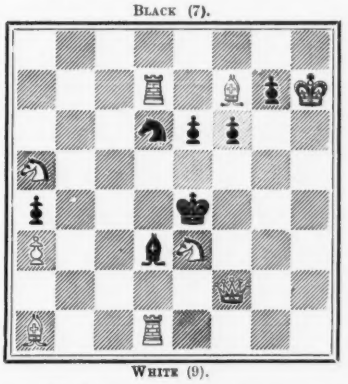
P. A. Cobbold (Ontario).—Your solution of No. 1 (October) is correct, but K to B2 will not solve No. 2, BB5 being a valid defence. In the variation you give (2. QB6ch, K×P) there is nothing approaching a mate.

PROBLEMS.

No. 1.

By Jeff Allen (Calcutta).

BLACK (7).



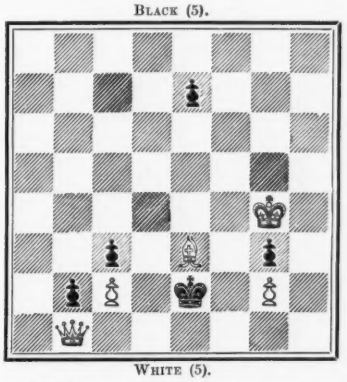
WHITE (9).

White mates in two moves.

No. 2.

By Major Nangle.

BLACK (5).



WHITE (5).

White mates in three moves.

CHESS INTELLIGENCE.

"KNOWLEDGE" SOLUTION TOURNEY.

A Solution Tourney is to be started in KNOWLEDGE, in the January number of the journal. The sum of One Guinea is offered as First Prize, and KNOWLEDGE free for twelve months as Second Prize. The conditions are as follows :—

1. The Tournament will begin on January 1st, 1901, and will include all the direct mates in two and three moves printed in KNOWLEDGE during the year 1901.
2. If a Problem be incorrectly printed it will be cancelled and reprinted.
3. Key-moves only need be given. A correct key to a two-move Problem will score two points, to a three-move Problem, three points. A *second* solution will score one point. An incorrect claim for a second solution will lose one point. If a Problem has no solution, the fact must be stated; it will then count as a correct key.
4. In the event of a tie for either prize, the Chess Editor may decide it by a further trial of skill under new conditions.

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5. Solutions must bear postmark not later than the 10th of the month of publication.

The British Chess Company (Stroud, Gloucester) have brought out a miniature chess-board, on the *In statu quo* principle. It consists of a neat, strong cardboard box ($5\frac{1}{2} \times 4 \times \frac{1}{2}$ inch). Fixed to the bottom of the box is a chess board drilled with holes, extra holes being provided for the captured men. The men are ebony and box wood, with pegs to fit into the holes. The price for one set is 2s. 6d., for three sets 6s. 9d, and for six 12s. Altogether it is a very neat and useful contrivance.

The following characteristic game was played by Mr. Steinitz in the Vienna Tournament of 1882. In that tournament he divided the first and second prizes with Herr Winawer. The notes are from KNOWLEDGE of that year.

French Defence.

WHITE. W. Steinitz.	BLACK. B. Fleissig.
1. P to K4	1. P to K3
2. P to K5 (*a*)	2. P to Q4
3. P × P *en pass.*	3. B × P (*b*)
4. P to Q4	4. Kt to K2
5. B to Q3	5. Kt to Kt3 (*c*)
6. Kt to KB3	6. Kt to B3
7. Kt to B3	7. Kt to Kt5 (*d*)
8. BQ to B4	8. P to QB3
9. Kt to K4 (*e*)	9. B to B2
10. Castles	10. Castles
11. R to K	11. Kt to Q4
12. Kt to B5	12. Kt to R5
13. Kt to K5	13. Kt to B4 (*f*)
14. PQ to B3	14. B × Kt
15. R × B	15. Kt to B3
16. R to Ksq. (A)	16. P to KR3
17. Q to B3 (*g*)	17. Kt to Q4
18. B to Kt3	18. P to QKt3 (*h*)
19. Kt to Q3	19. B to R3
20. Kt to K5	20. R to Bsq
21. B to B2	21. Kt (B4) to K2
22. Q to Kt3	22. K to Rsq
23. Q to R4	23. K to Ktsq (*i*)
24. Q to Kt3	24. K to Rsq
25. Q to R3	25. Kt to Ktsq
26. Q to R5	26. R to B2
27. B to Q2 (*j*)	27. QKt to B3
28. Q to R3	28. Kt to Q4 (*k*)
29. P to QB4	29. QKt to B3
30. QR to Qsq (*l*)	30. Q to Ksq (*m*)
31. B to B4 (*n*)	31. R to Bsq (*o*)
32. Q to R3 (*p*)	32. B to Kt2
33. Q × P	33. B to Rsq
34. Q × KtP	34. P to Kt4
35. B to Kt3	35. Kt to Q2
36. Q to Kt3	36. P to KB4
37. P to B3	37. K to Kt2
38. P to B5 (*q*)	38. QKt to B3
39. Kt to B4	Resigns (*r*)

NOTES.

(*a*) Not usually played. The object is to confine the Queen's Bishop, and hamper Black's game.

(*b*) Perhaps to be preferred to P × P, as the two Pawns on the Queen's side would, at a later stage of the game, be subjected to attack.

(*c*) With a view of eventually playing P to K4.

(*d*) Black was afraid of Castling, on account of the commanding position of White's Bishop; for after Castles, White might at once proceed with P to KR4, Kt to Kt5, P to R5; that is to say, proceed upon the basis of attacking the Pawn at R2, of which we indicated the general lines; therefore Black wished to exchange that Bishop.

(*e*) This again places another piece in a favourable position; should Black play P to KB4, then his King's Pawn becomes weak, because unsupported by another Pawn, and therefore more liable to capture.

(*f*) All this is merely wrangling for good position, but Black is wasting time in trying to exchange pieces.

(A) QB3 might be played at once. For if Black replies Kt to Q2, then Kt × KP.—(C. D L.)

(*g*) This is Mr. Steinitz's old style; Black cannot move P to QKt3 now, even if he wished to do so, he suffers from the inconvenience of having his Bishop blocked in.

(*h*) We shall see later on how the Pawn on B3 will fare.

(*i*) Black would be satisfied with a draw.

(*j*) Inch by inch the ground is won; this is a fine move. He intends at the suitable moment to push on his QBP and use the Bishop for attacking on the Queen's side, *via* Kt4.

(*k*) Playing into White's hands; the difficulty is, what to do? He dare not move the King's Knight, as White would play B × RP. Had Black played Kt to Q2, White might have responded with Kt to Kt4, threatening the dangerous Kt × RP, which would yield White a winning attack.

(*l*) White is in no hurry; he goes steady but sure. This move will further aid White, as the Black QBP cannot be now advanced.

(*m*) With the object of avoiding a discovered attack on his Queen, but it cramps his pieces very much.

(*n*) White changes the originally intended move, for if he had played B to Kt4, P to B4, etc.

(*o*) R to K2 was the only other move. Black's Rook is brought into awkward play, on account of the necessity of defending QBP, showing plainly how a strong player will take advantage of even a very slight weakness.

(*p*) White pressed on in sometimes an almost imperceptible manner, and now he has gained the desired opportunity. He wins two Pawns and the game, he having by sheer good judgment outmanœuvred his opponent.

(*q*) A fine move. It further tightens his already strong hold. He intends playing his Kt to Q6.

(*r*) Black simply has no good move; he is crushed. If R to Ksq, then B × BP. White also threatens to win by Kt to Q6. If Q to Qsq, then of course R × P.

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